Images for BIOMECHANICS

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Images for BIOMECHANICS

Introduction

This collection contains a variety of images for use in the teaching of Biomechanics. They are designed as focal points for explanations, discussions, and revision. The written content is kept to a minimum, and with a few exceptions they can be used at almost any level at the discretion of the tutor.

Images for BIOMECHANICS

Contents List

Levers

1 Different Types of Lever

Linear Motion

2 The Run - Resultant ground reaction force.

3 The Run - Graph showing the vertical ground reaction force and gravitational force acting on a sprinter whilst in contact with the starting blocks.

4 The Run - Graph showing the net vertical ground reaction force acting on a sprinter whilst in contact with the starting blocks.

5 The Run - Graph showing the vertical ground reaction force of a single footfall during a 100m race.

6 The Run - Graph showing the net vertical ground reaction force of a single footfall during a 100m race.

7 The Run - Graph showing the horizontal ground reaction force acting on a sprinter whilst pushing against the starting blocks.

8 The Run - Graph showing the horizontal ground reaction force acting on sprinter during one footfall early in a 100m race.

Contents continued

9 **The Run** - Graphs showing the horizontal ground reaction force acting on a sprinter during one footfall in the middle and at the end of a 100m race.

10 **The Vertical Jump** - Graph showing the changes in position of a performer's centre of gravity during the take-off phase of a vertical jump.

11 **The Vertical Jump** - Graph showing the vertical velocity during the take-off phase of a vertical jump

12 **The Vertical Jump** - Graph showing vertical ground reaction force during the take-off phase of a vertical jump.

13 **The Vertical Jump** - Series of graphs showing the vertical ground reaction force, gravitational force, and net force of a jumper during the take-off phase of a vertical jump (Part A).

14 **The Vertical Jump** - Series of graphs showing the vertical ground reaction force, gravitational force, and net force of a jumper during the take-off phase of a vertical jump (Part B).

15 **The Vertical Jump** - Series of graphs showing the vertical ground reaction force, gravitational force, and net force of a jumper during the take-off phase of a vertical jump (Part C).

16 **The Vertical Jump** - Series of graphs showing the vertical ground reaction force, gravitational force, and net force of a jumper during the take-off phase of a vertical jump (Part D).

17 **The Vertical Jump** - Graph showing the net force acting on a jumper during the take-off phase of a vertical jump.

18 **The Vertical Jump** - Graph showing the vertical ground reaction force and gravitational force acting on a jumper during the take-off phase of a vertical jump.

19 **The Vertical Jump** - Graph showing a representation of the net impulse acting during the take-off phase of a vertical jump.

Contents continued

Centre of Gravity

20 **Net Force and Centre of Gravity** - The handstand

21 **Net Force and Centre of Gravity** - Withstanding impact from the side.

22 **Changing position of the Centre of Gravity** - Various body positions.

23 **High Jump Technique** - The ‘scissors’ and the ‘Fosbury flop’.

Angular Motion

24 **Rotation** - Weight generating torque force about a supported axis.

25 **Rotation** - Weight generating torque force about a non-supported axis.

26 **Rotation** - Weight generating torque force about a point of contact axis.

27 **Rotation** - Stages of a flick-flak (0.08s intervals).

28 **Rotation** - Ground reaction force generating torque.

29 **Rotation** - Graph showing torque force during the take-off phase of a flick-flak.

30 **Rotation** - Graph showing the relationship between moment of inertia and angular velocity in a standing back somersault (flight phase).

31 **Angular velocity** - Graphs showing angular position and angular velocity of upper leg during running cycle.

32 **Angular velocity** - Graphs showing angular position and angular velocity of lower leg during running cycle.

Contents continued

Fluid Forces

33 **Bernoulli Effect** - Lamina flow around a slow moving ball and a fast moving ball.

34 **Reduced Drag** - Late separation of air flow by travelling above the critical velocity.

35 **Swing** - Disturbing the air using the seam on a cricket ball.

36 **Magnus Effect** - Lift force created by 'spin'.

37 **Magnus Effect** - Lift force lift force at 90^{o} to the direction of travel.

38 **Boundary Layer** - Laminar flow around a discus.

Parabolas

39 **Symmetry** - The symmetrical parabola.

40 **Range** - Optimum release angle for height for maximum range.

41 **Air Resistance** - Asymmetric parabolic flight path due to air resistance.

42 **Velocity Vector** - Resultant of vertical velocity component and horizontal velocity component.

43 **Velocity Vector** - Parabolic flight path showing horizontal component only.

44 **Velocity Vector** - Parabolic flight path showing vertical component only.

45 **Velocity Vector** - Changes in the vertical velocity component of the parabolic flight path of a projectile (shot put) with the landing point lower than the release point.

46 **Velocity Vector** - Long jump vertical and horizontal velocity components of a long jump flight parabola.

47 **Jumps** - Centre of gravity parabola of 'Fosbury flop'.

48 **Jumps** - Altering the position of the body in relation to the centre of gravity in a jump to 'Hang in the Air'.

Images for BIOMECHANICS

Levers

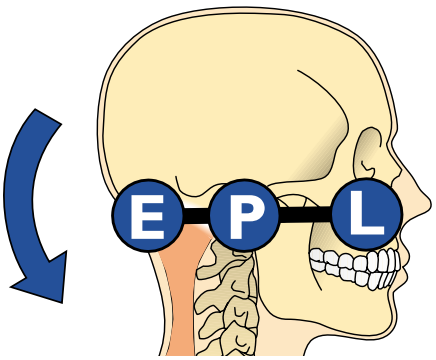
1 Levers Different Types of Lever

1 2 3 = P L E

1st Order Lever

Pivot *(fulcrum)* between
effort and load
E – P – L

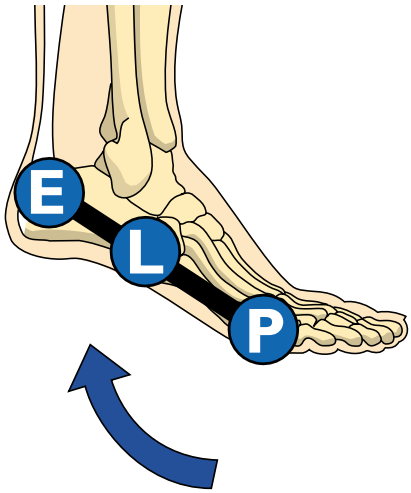
eg: atlas vertebrae to skull joint



2nd Order Lever

Load between
Effort and Pivot
E – L – P

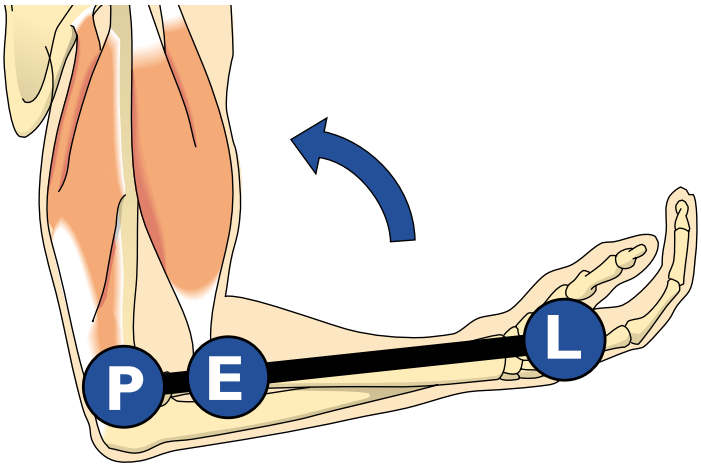
eg: ankle joint



3rd Order Lever

Effort between
Load and Pivot
P – E – L

eg: elbow joint

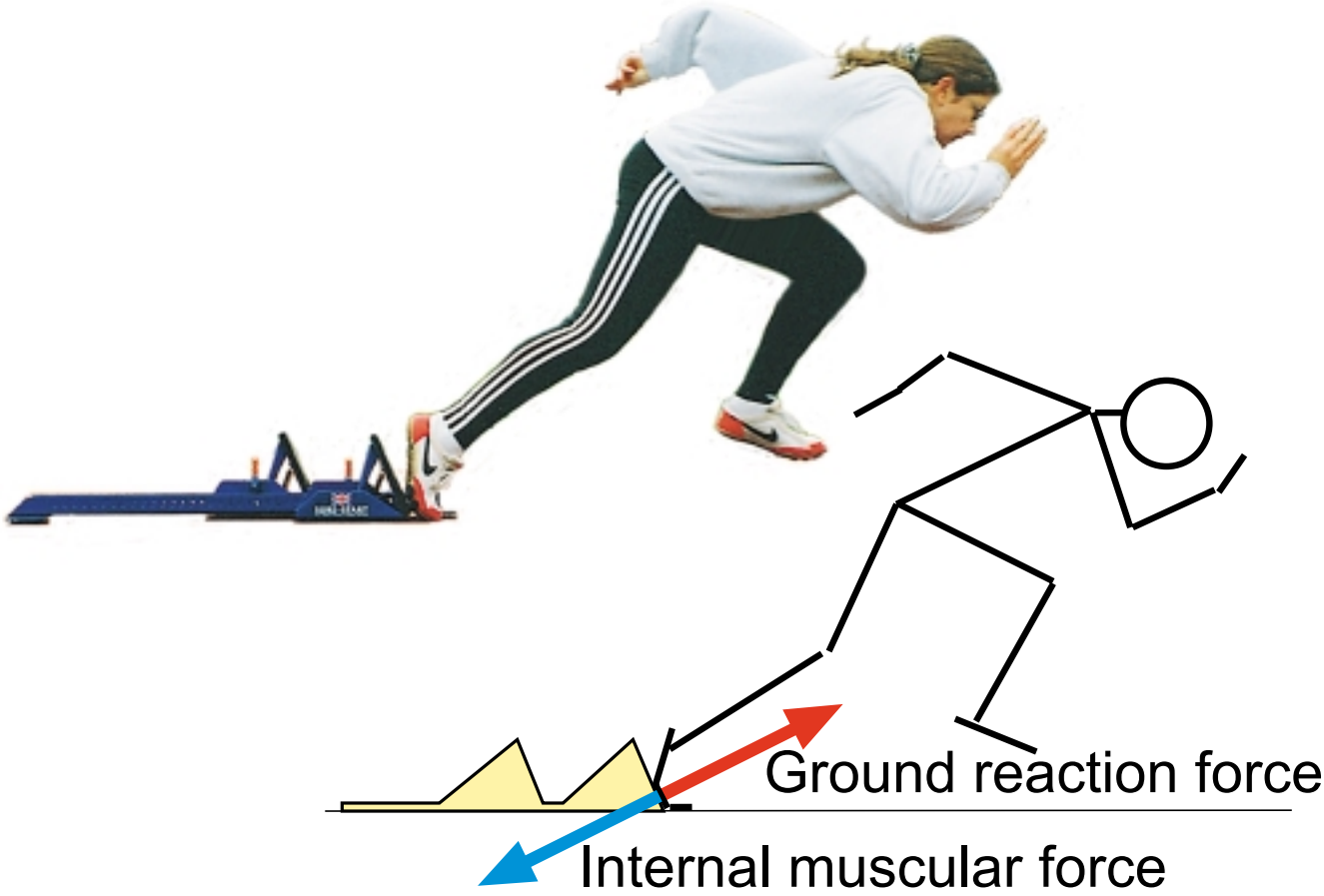


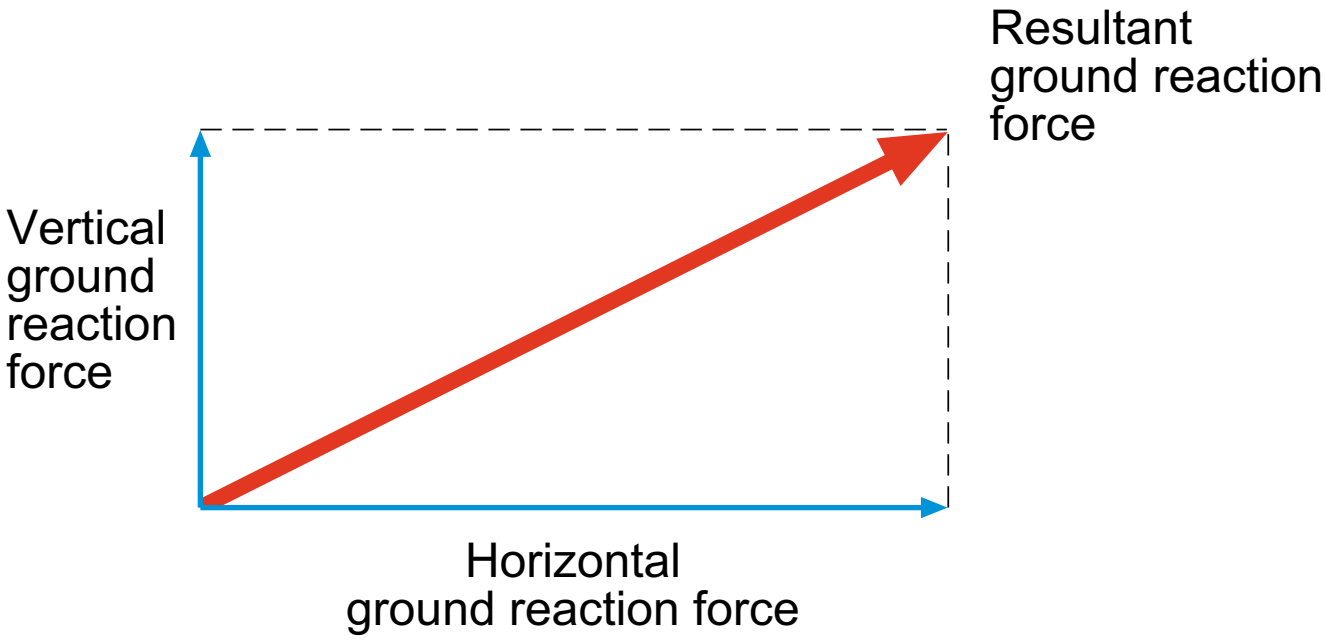
Images for BIOMECHANICS

Linear Motion

2 Linear Motion The Run

Resultant ground reaction force

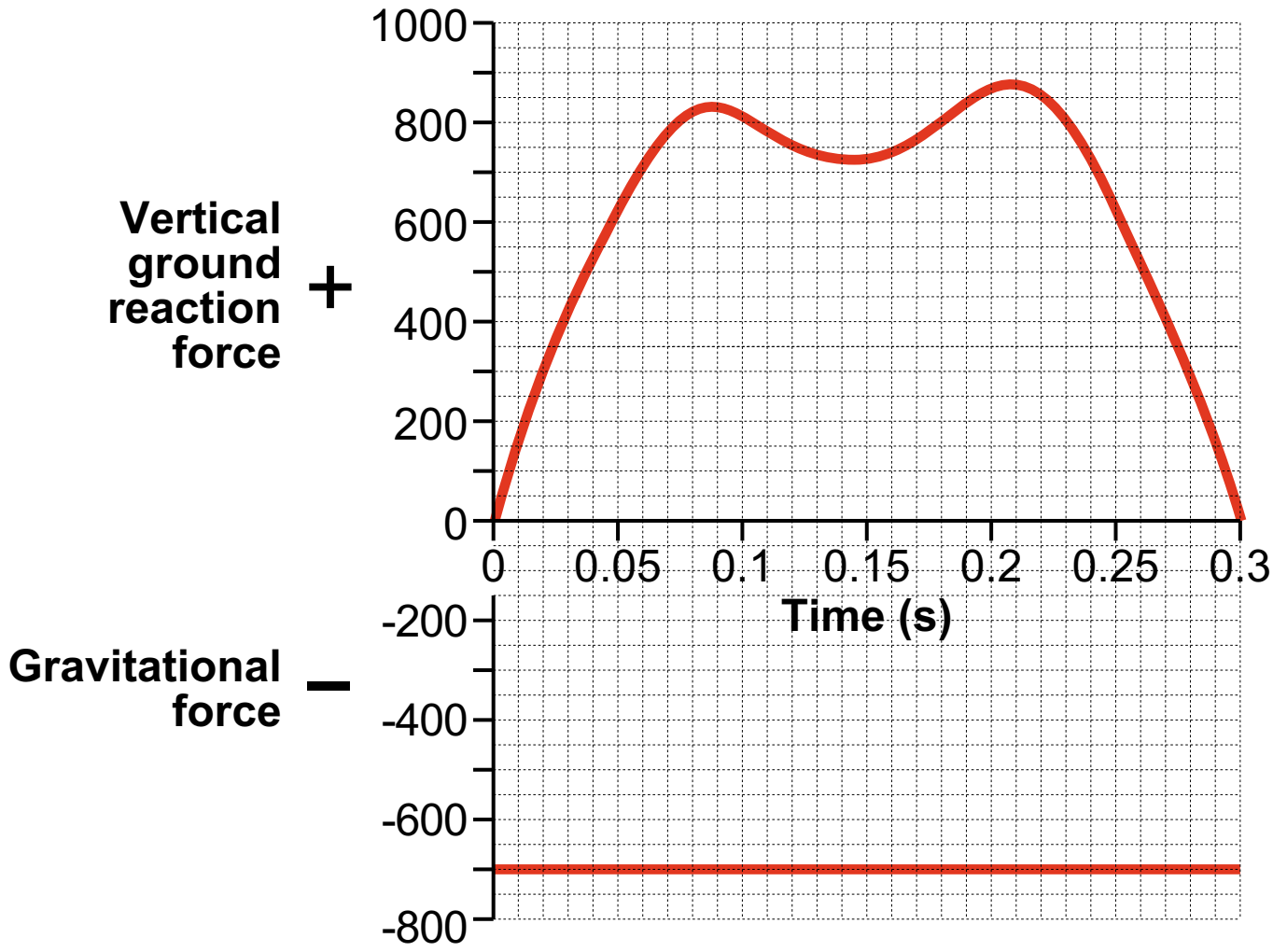




3 Linear Motion

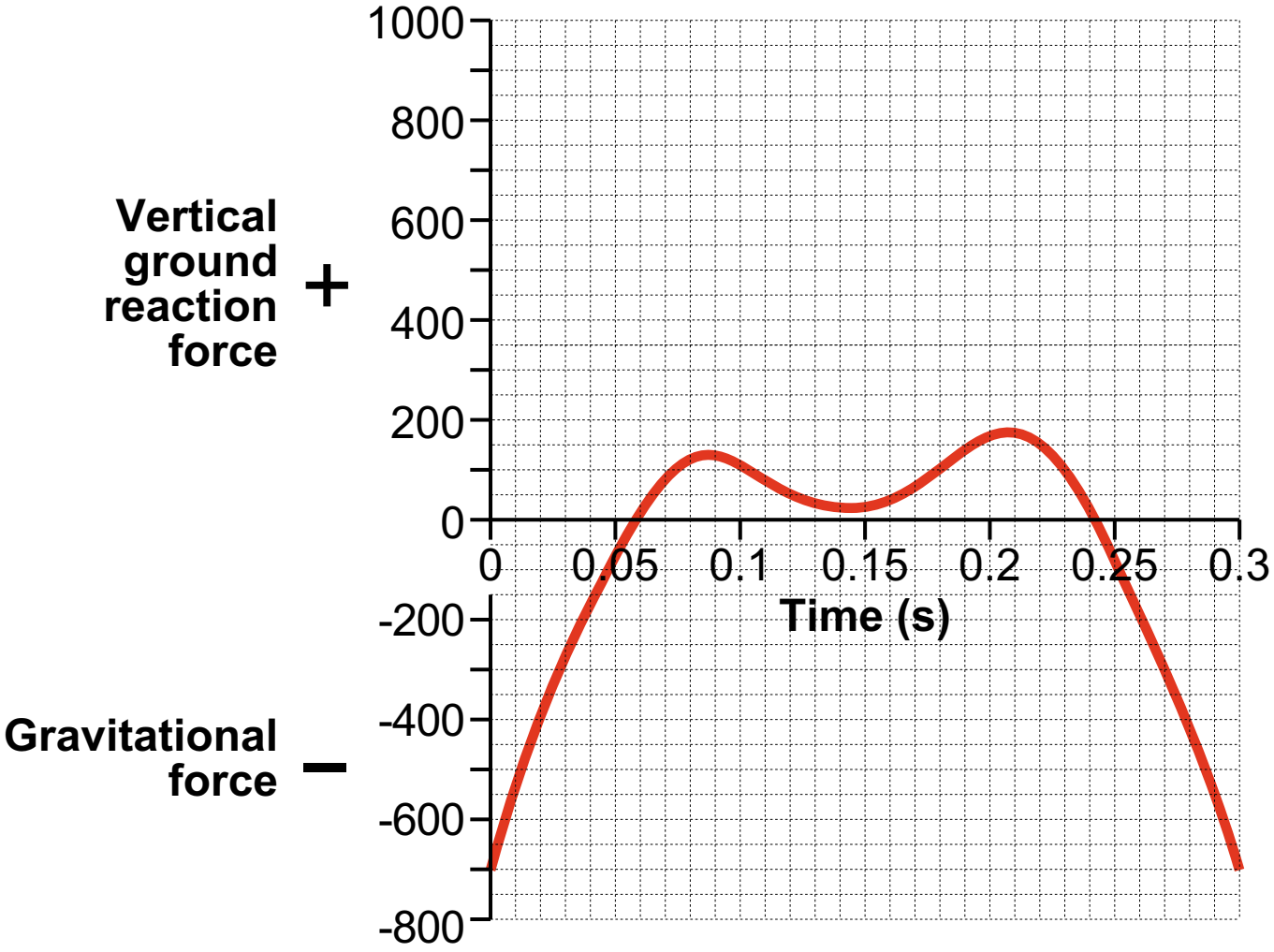
The Run

Graph showing the vertical ground reaction force and gravitational force acting on a sprinter, whilst in contact with the starting blocks.



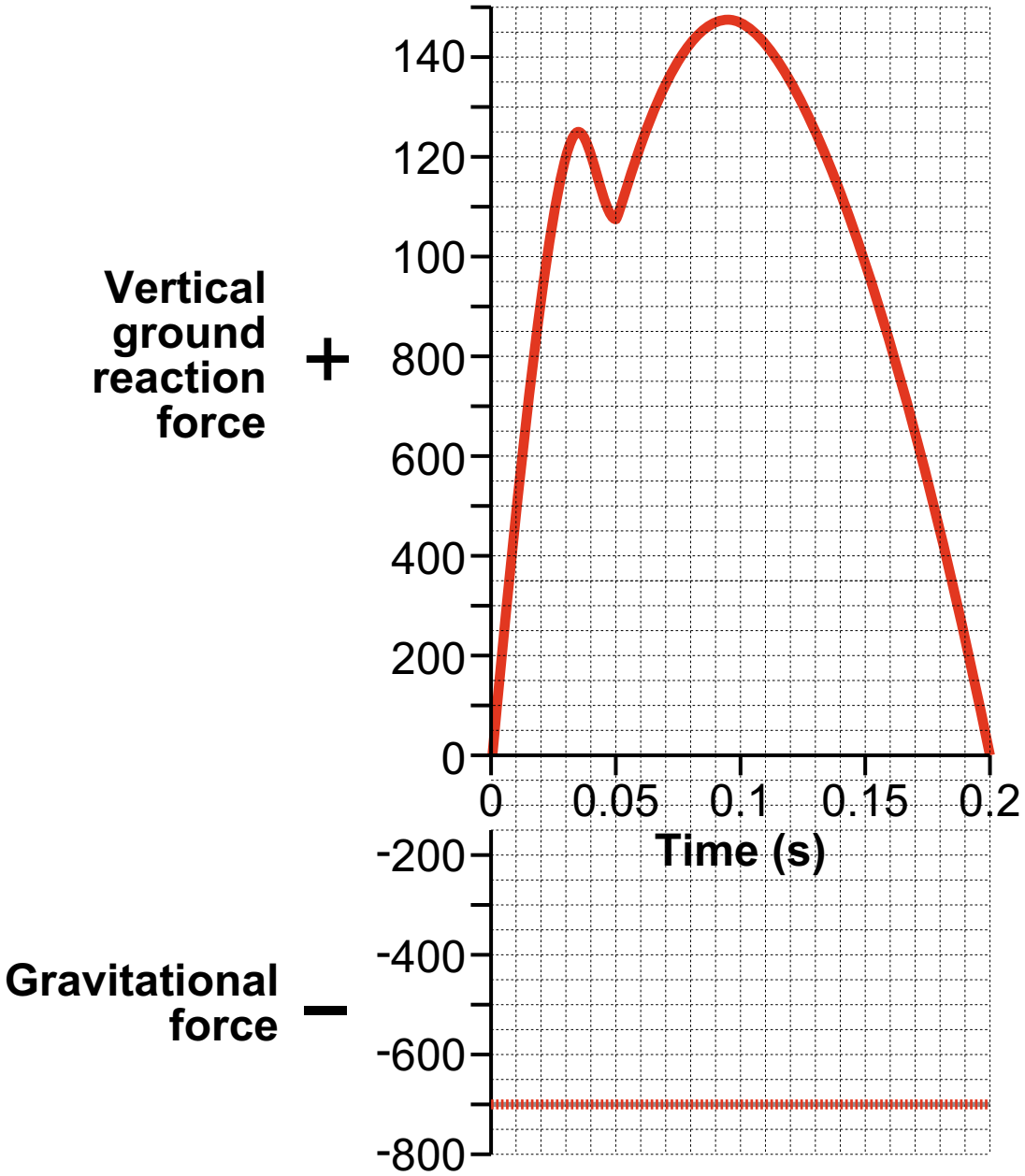
4 Linear Motion The Run

Graph showing the net vertical ground reaction force acting on a sprinter, whilst in contact with the starting blocks.



5 Linear Motion The Run

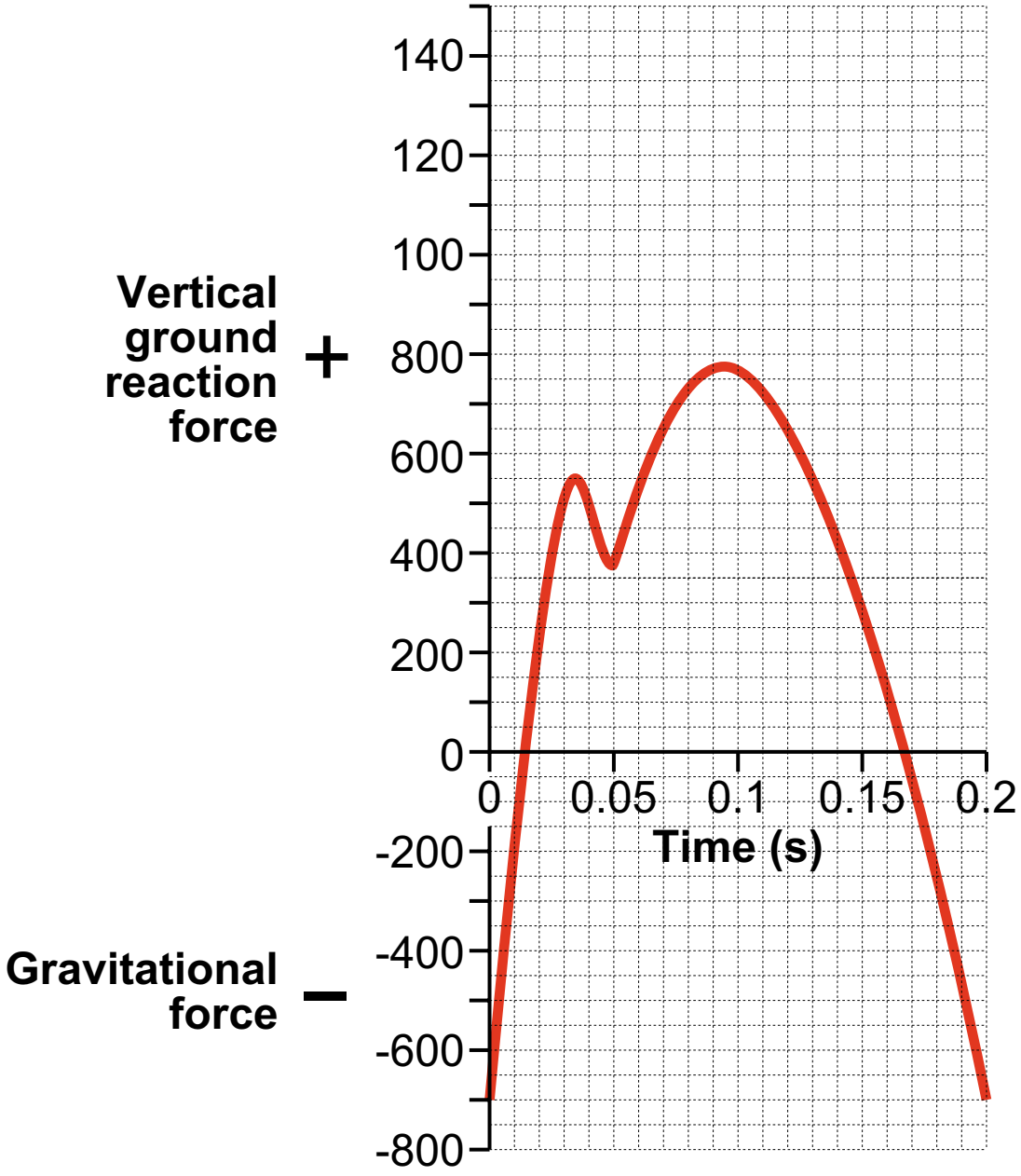
Graph showing the vertical ground reaction force of a single footfall during a 100m race.



Unlike the horizontal ground reaction force, the vertical ground reaction force pattern shows little change throughout the race. In fact, the pattern displayed is typical of traces produced by a wide variety of runners over a wide range of speeds.

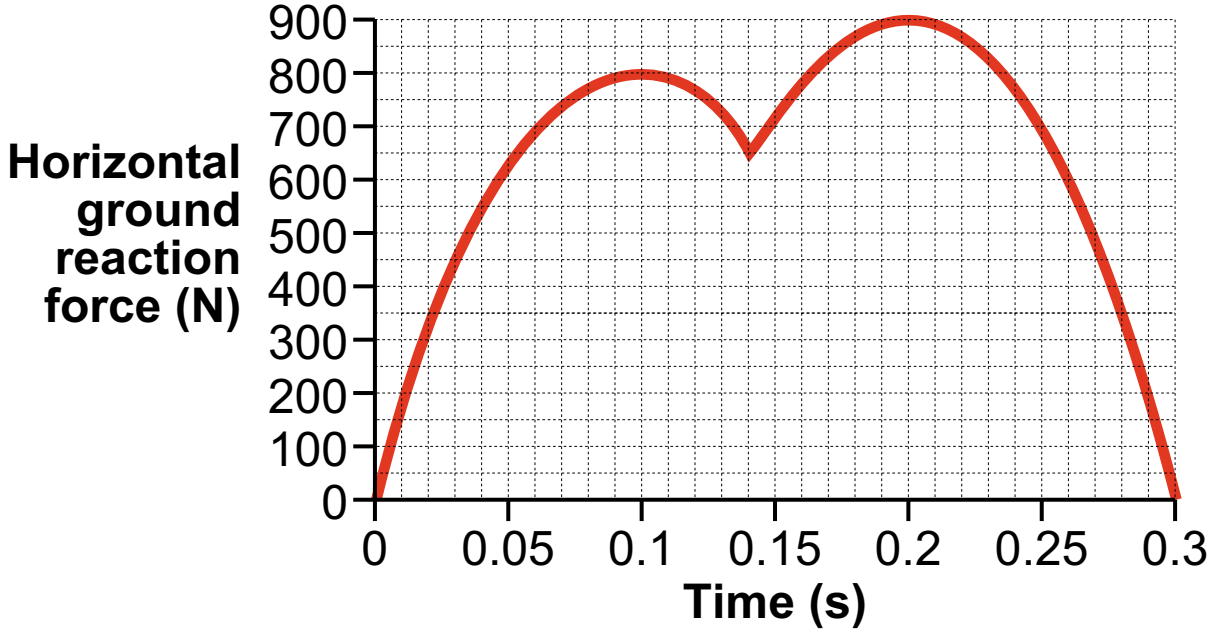
6 Linear Motion The Run

Graph showing the net vertical ground reaction force of a single footfall during a 100m race.



7 Linear Motion The Run

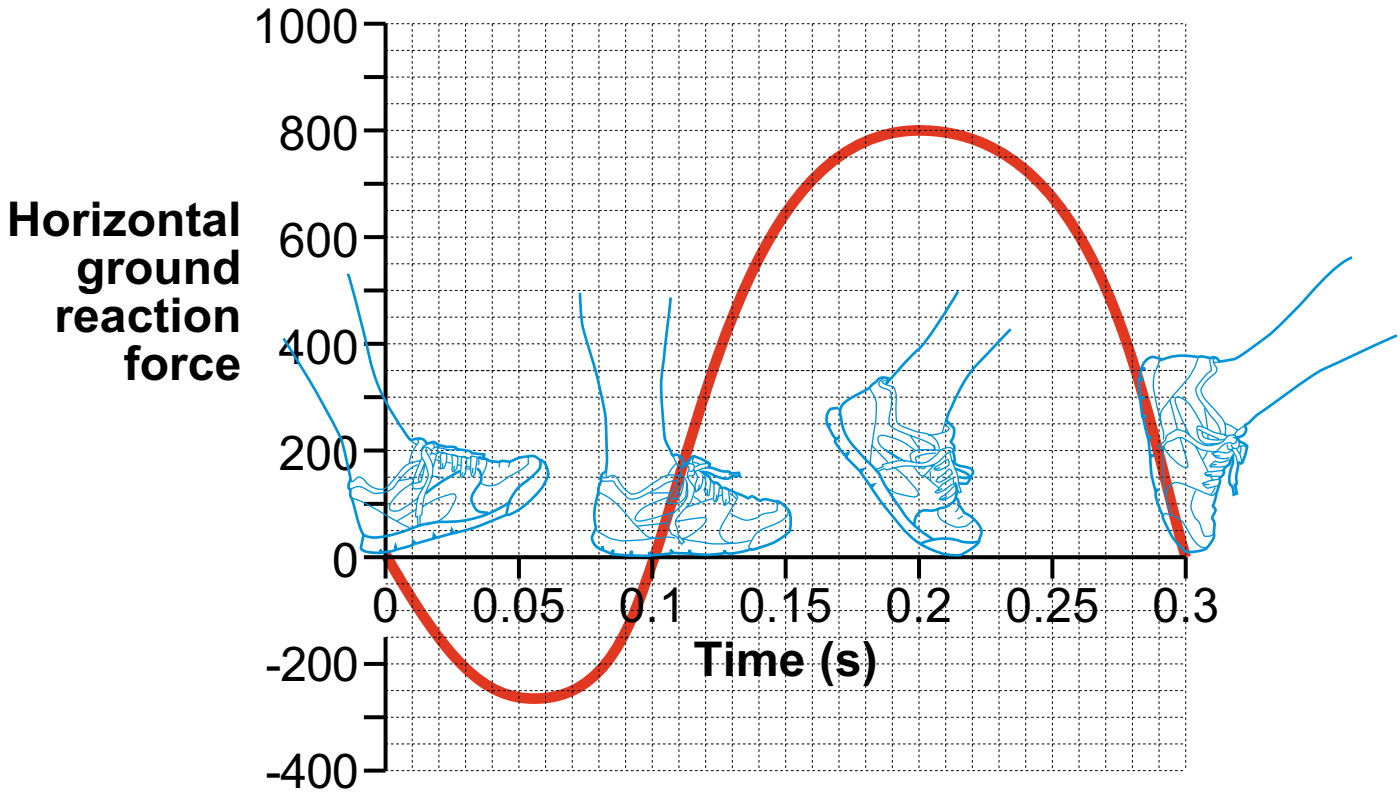
Graph showing horizontal ground reaction force acting on a sprinter whilst pushing against the starting blocks.



The curve represents the force exerted by both feet on the blocks. The double peak is the result of changing forces as the back foot leaves the rear blocks first, & the front leg moves through into a stronger driving position before also leaving the blocks.

8 Linear Motion The Run

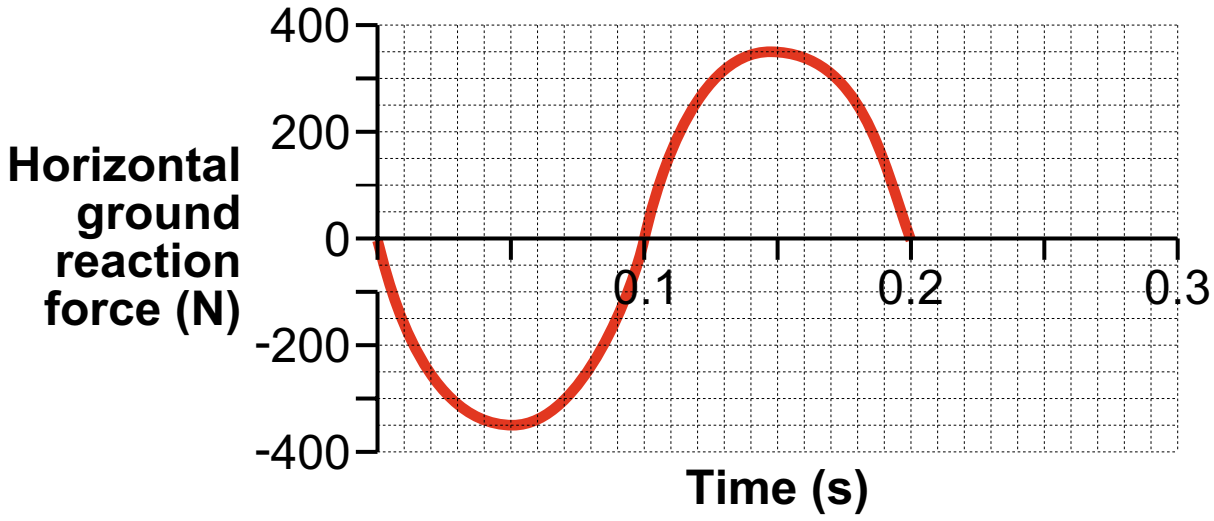
Graph showing horizontal ground reaction force acting on sprinter during one footfall early in a 100m race.



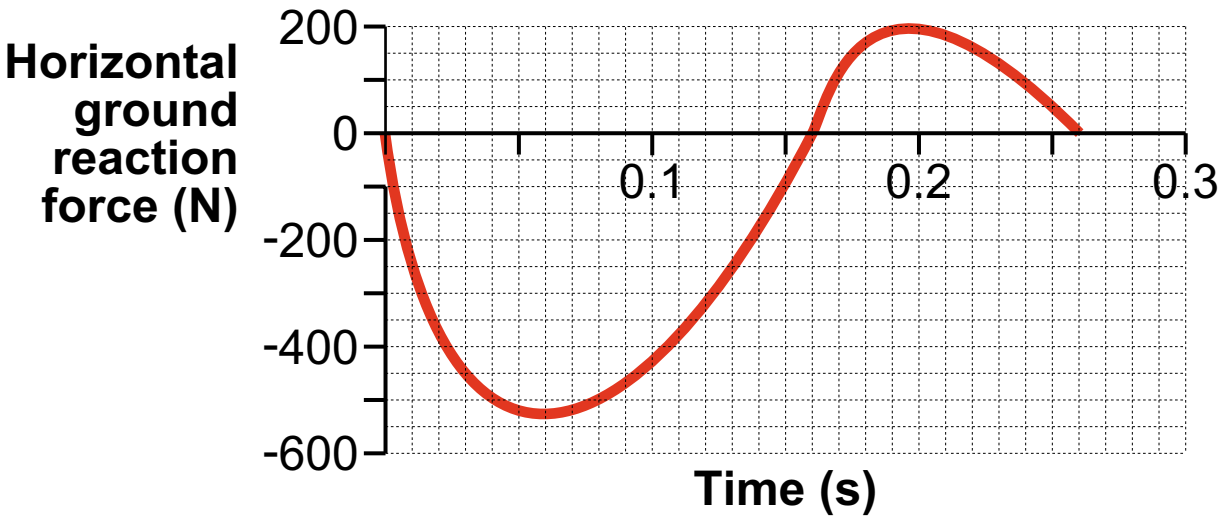
9 Linear Motion The Run

Graphs showing horizontal ground reaction force acting on a sprinter during one footfall in the middle and at the end of a 100m race.

Horizontal ground reaction force acting on a sprinter during one footfall in the middle stages of a 100m race.

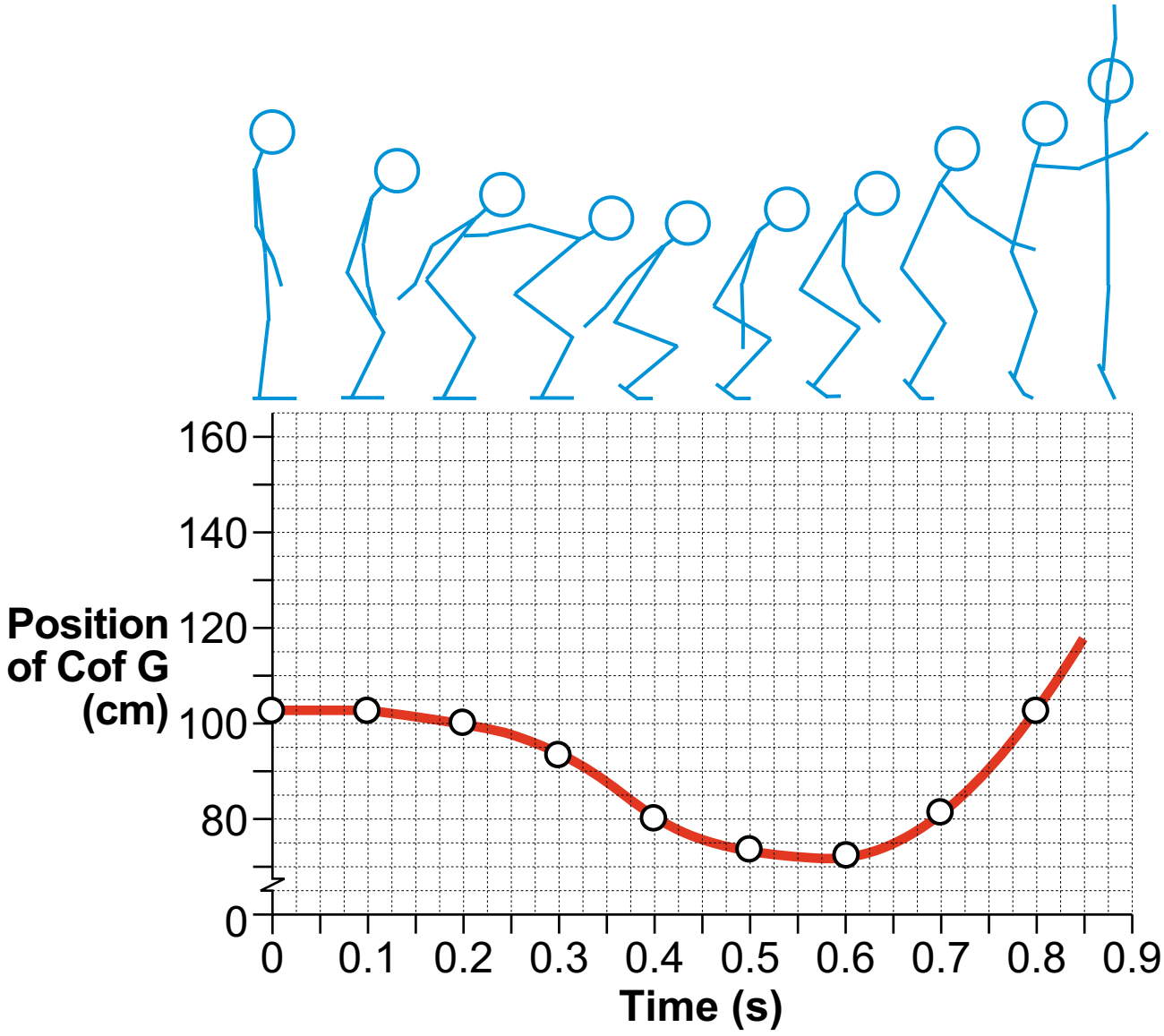


Horizontal ground reaction force acting on a sprinter during one footfall at the end of a 100m race.



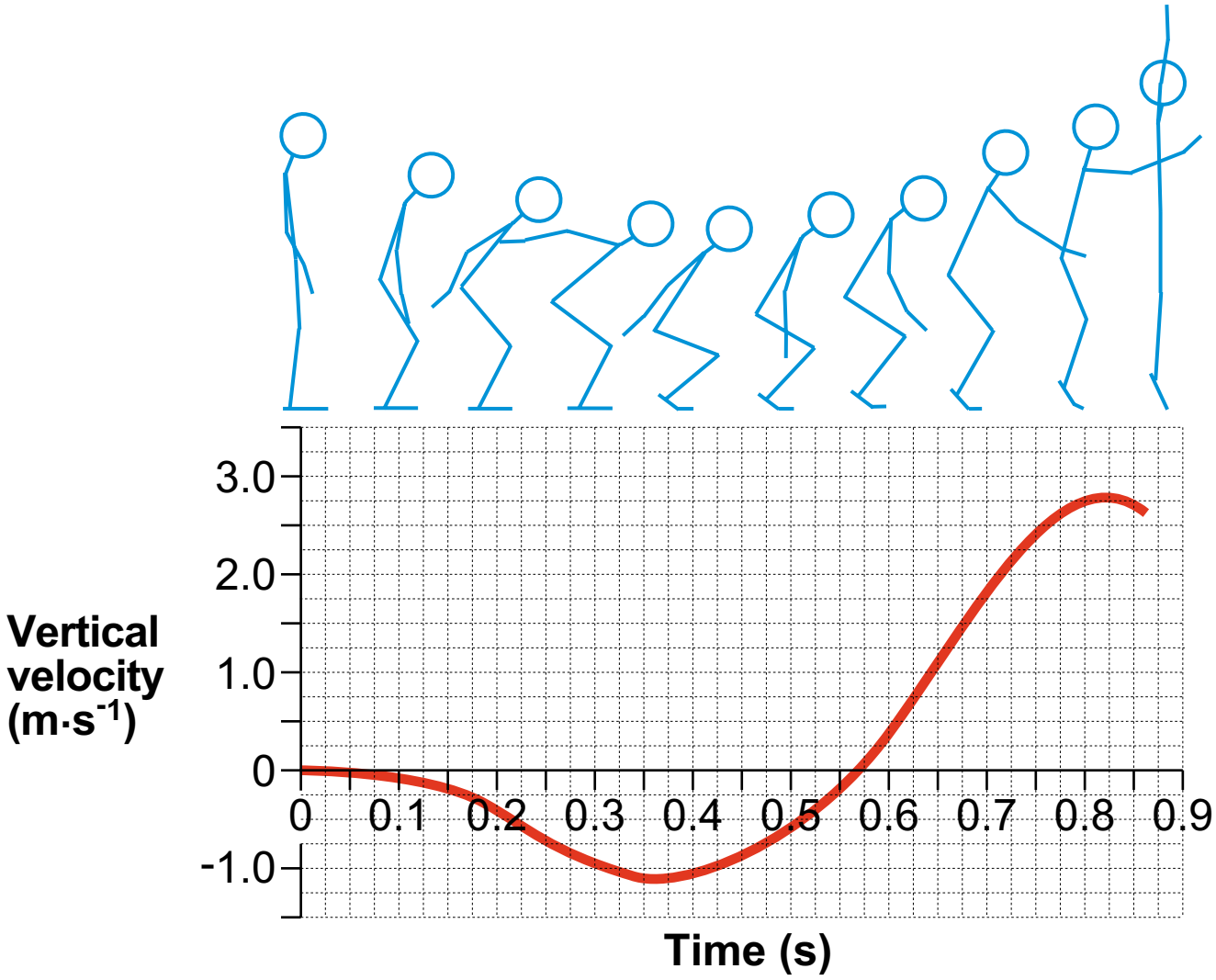
10 Linear Motion The Vertical Jump

Graph showing the changes in position of a performer's centre of gravity during the take-off phase of a vertical jump.



11 Linear Motion The Vertical Jump

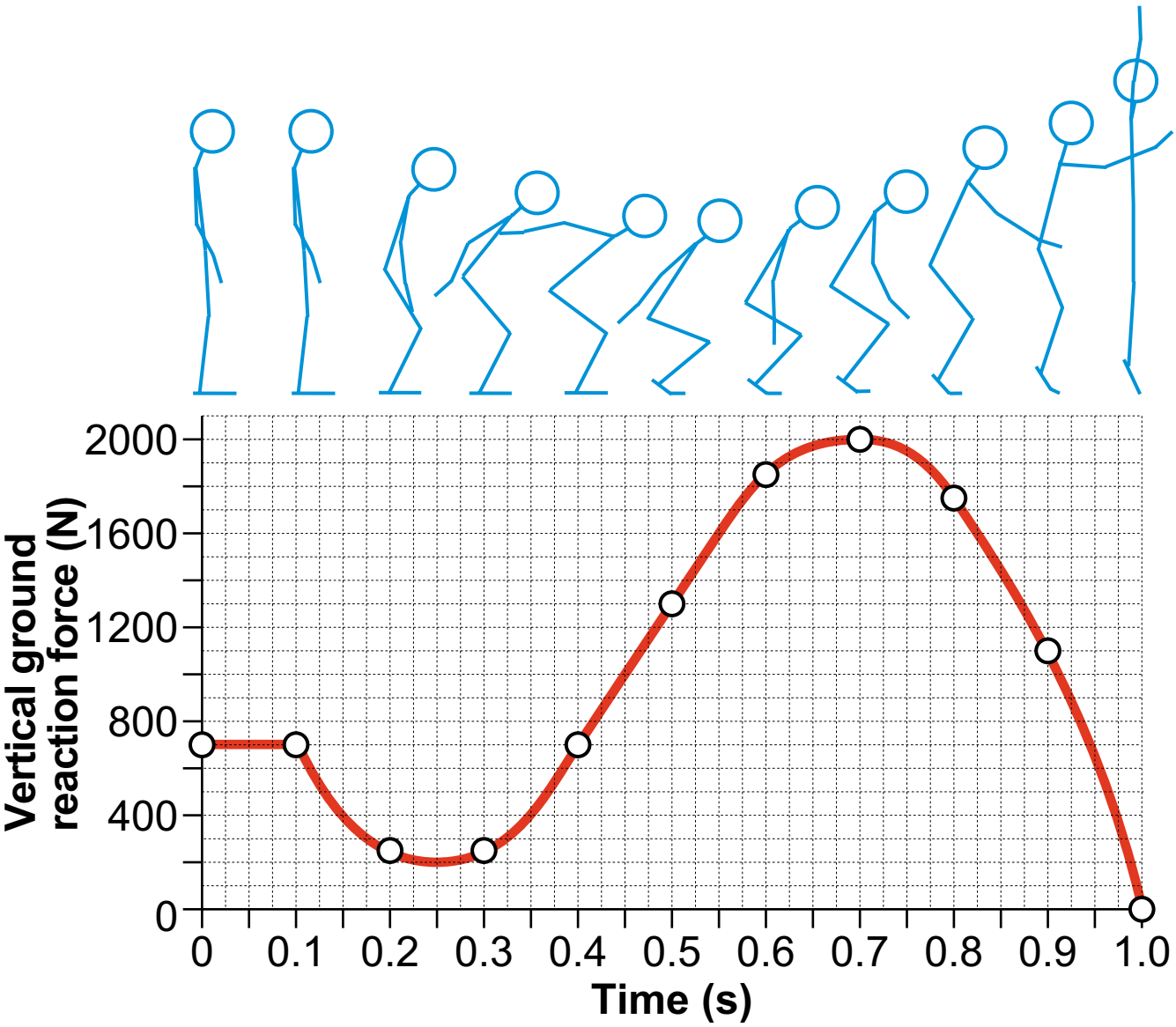
Graph showing the vertical velocity during the take-off phase of a vertical jump.



12 Linear Motion

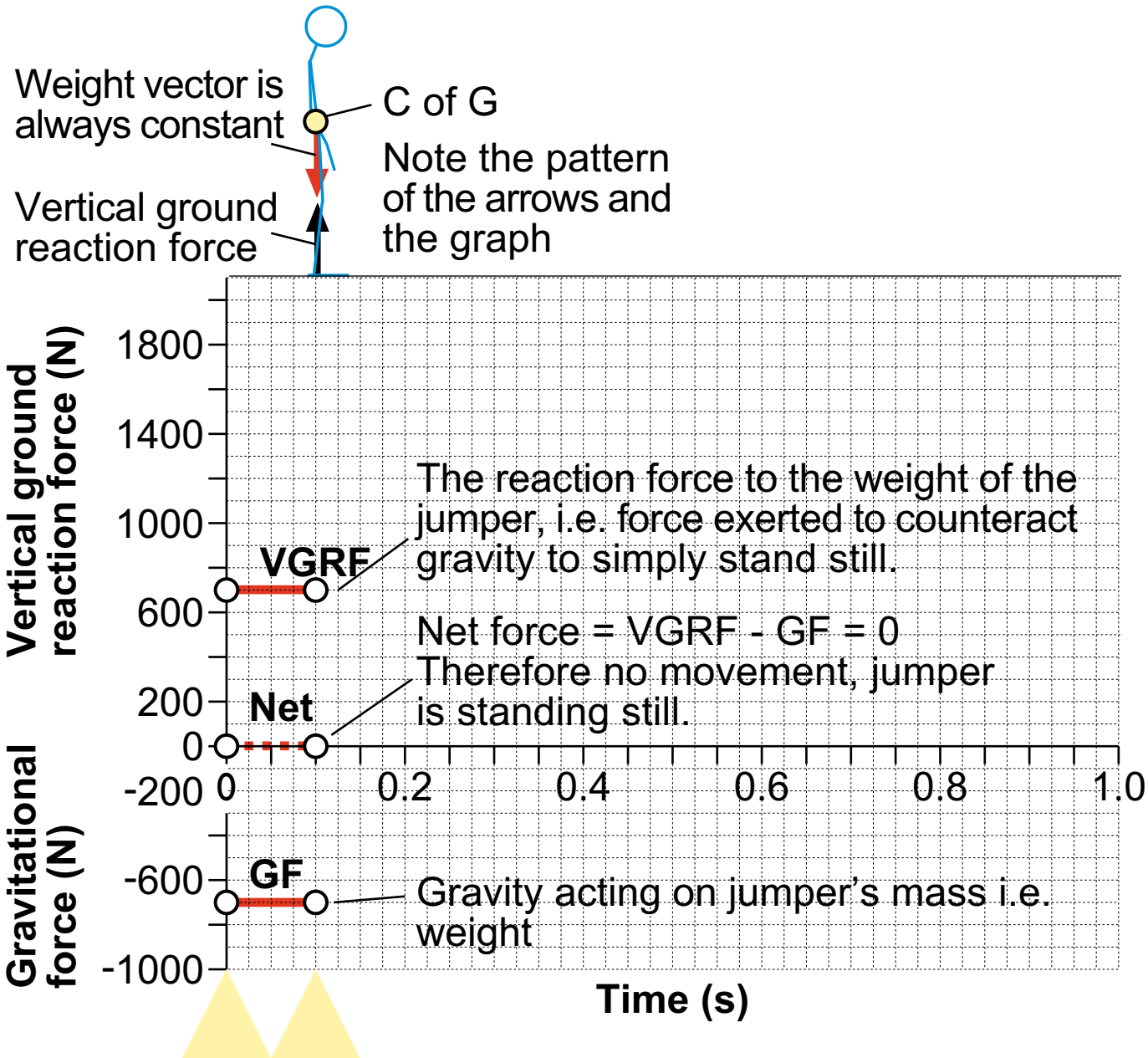
The Vertical Jump

Graph showing the vertical ground reaction force during the take-off phase of a vertical jump.



13 Linear Motion The Vertical Jump

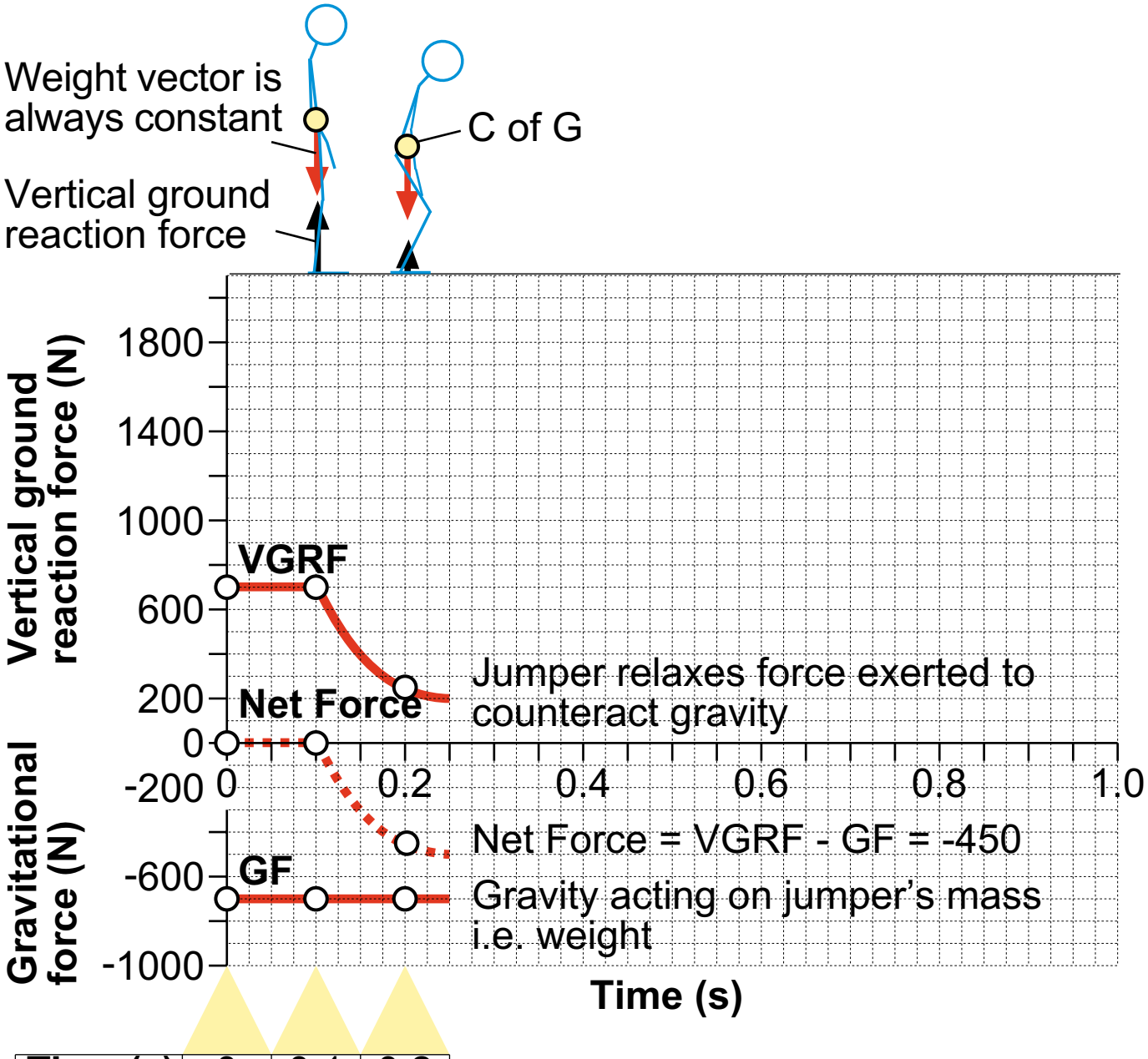
Series of graphs showing the vertical ground reaction force (VGRF), gravitational force (GF) and net force (NF) of a jumper during the take-off phase of a vertical jump (Part A).



Time (s)	0	0.1
V G R F	700	700
G F	-700	-700
Net	0	0

14 Linear Motion The Vertical Jump

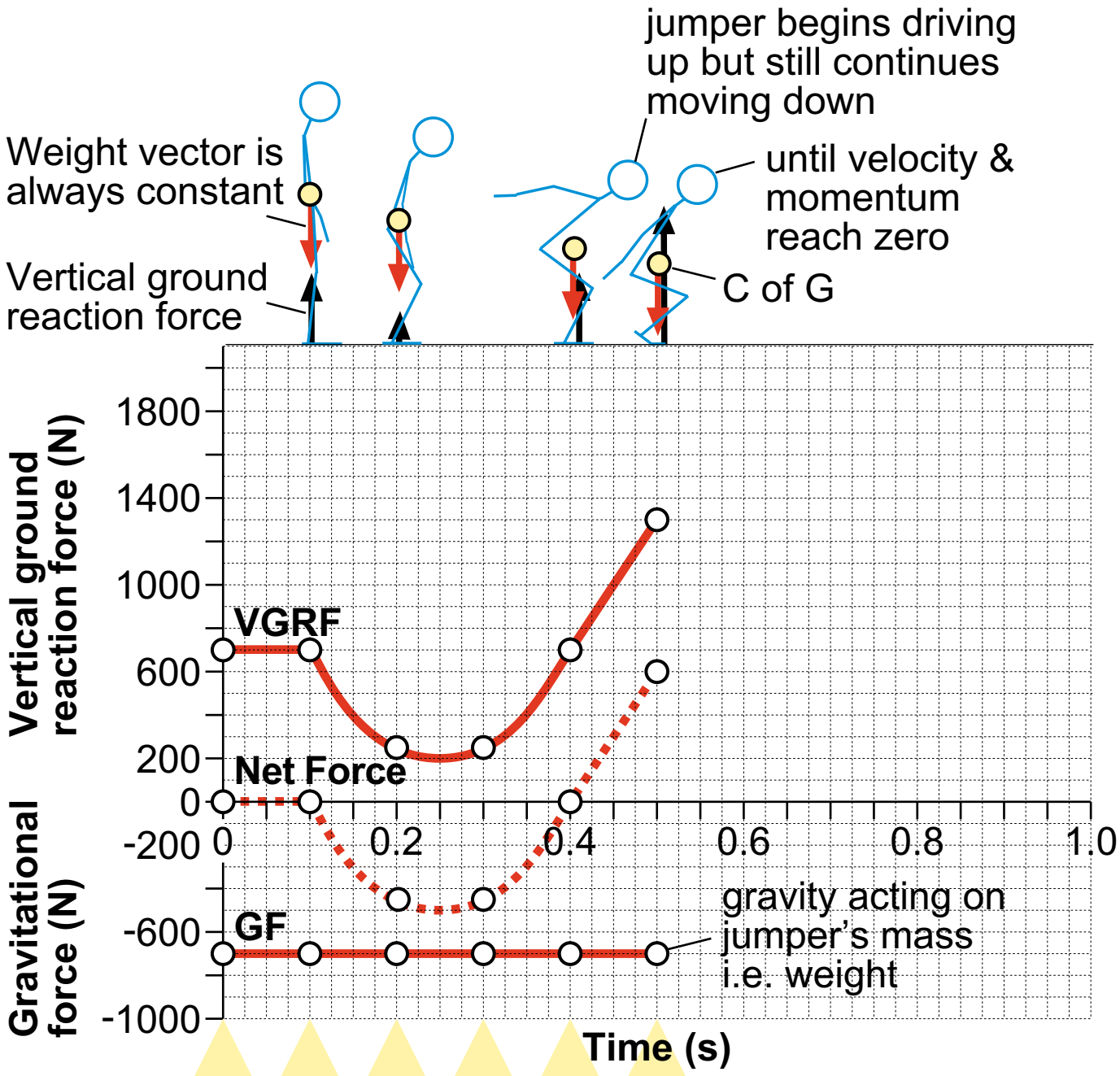
Series of graphs showing the vertical ground reaction force (VGRF), gravitational force (GF) and net force (NF) of a jumper during the take-off phase of a vertical jump (Part B).



Time (s)	0	0.1	0.2
V G R F	700	700	250
G F	-700	-700	-700
Net	0	0	-450

15 Linear Motion The Vertical Jump

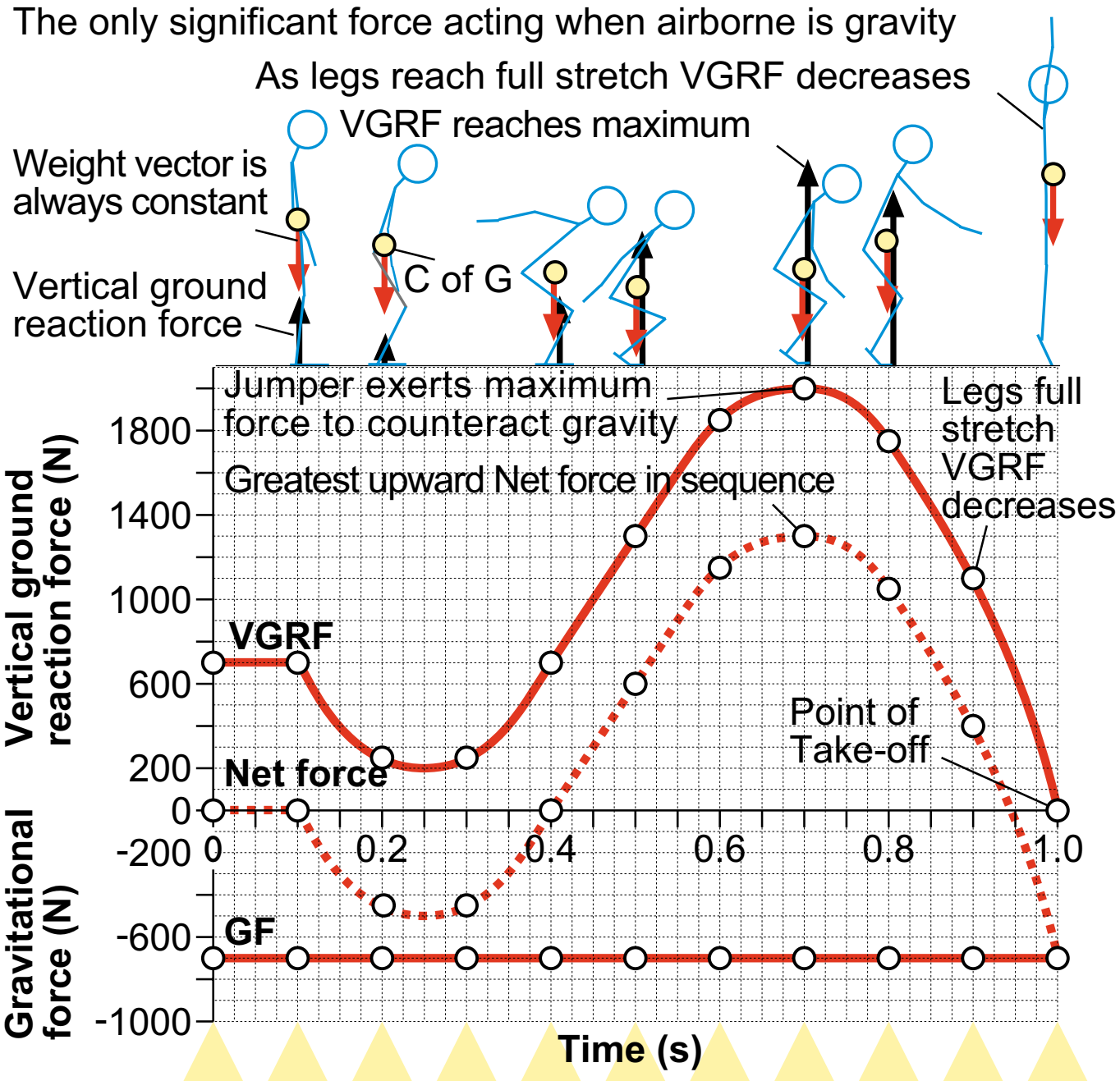
Series of graphs showing the vertical ground reaction force (VGRF), gravitational force (GF) and net force (NF) of a jumper during the take-off phase of a vertical jump (Part C).



Time (s)	0	0.1	0.2	0.3	0.4	0.5
V G R F	700	700	250	250	700	1300
G F	-700	-700	-700	-700	-700	-700
Net	0	0	-450	-450	0	600

16 Linear Motion The Vertical Jump

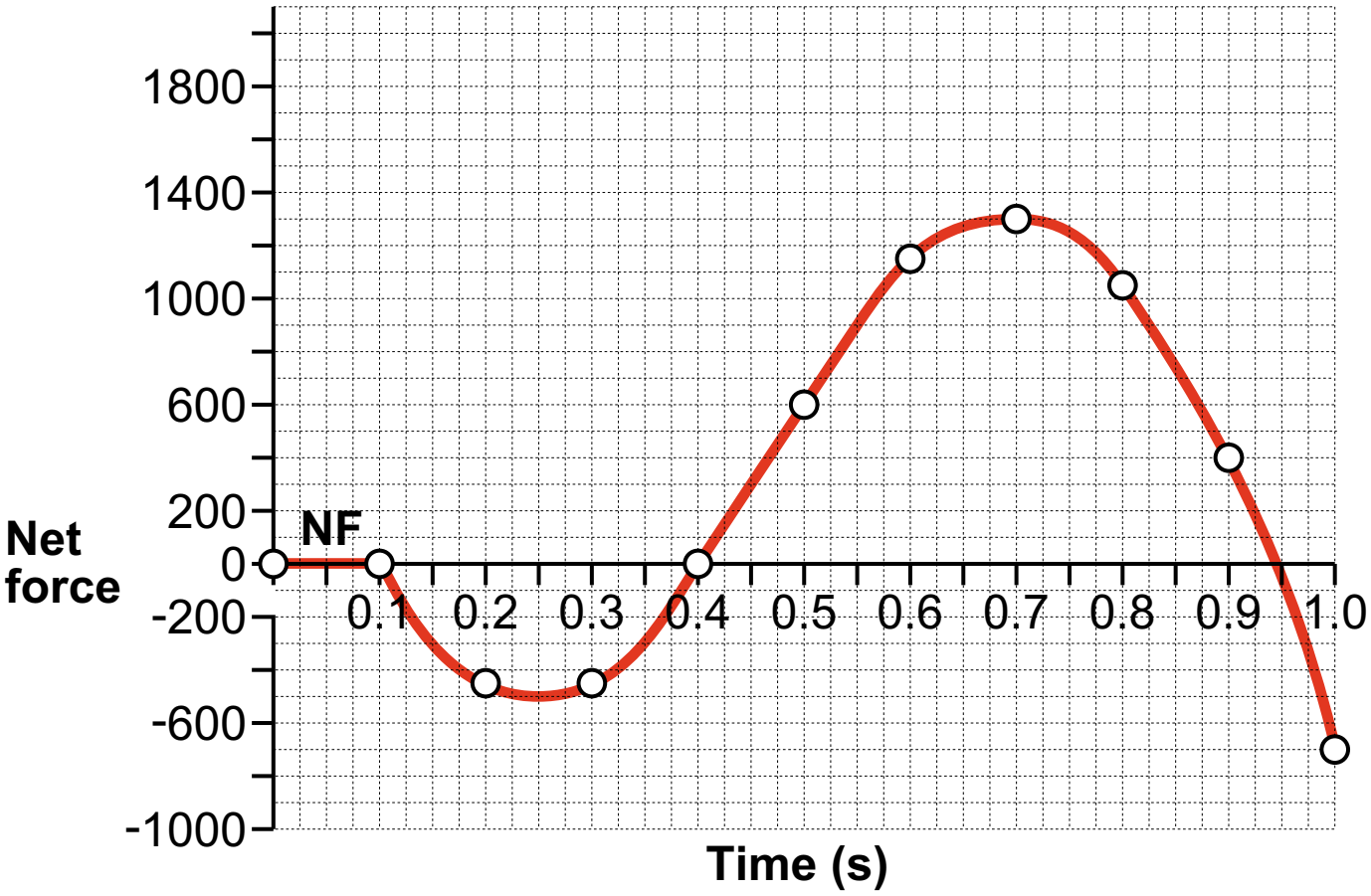
Series of graphs showing the vertical ground reaction force (VGRF), gravitational force (GF) and net force (NF) of a jumper during the take-off phase of a vertical jump (Part D).



Time (s)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
V G R F	700	700	250	250	700	1300	1850	2000	1750	1100	0
G F	-700	-700	-700	-700	-700	-700	-700	-700	-700	-700	-700
Net	0	0	-450	-450	0	600	1150	1300	1050	400	-700

17 Linear Motion The Vertical Jump

Graph showing the net force acting on a jumper during the take-off phase of a vertical jump.



Remember:

Net force = ground reaction force – gravitational force

If ground reaction force = gravitational force
then net force is **zero**

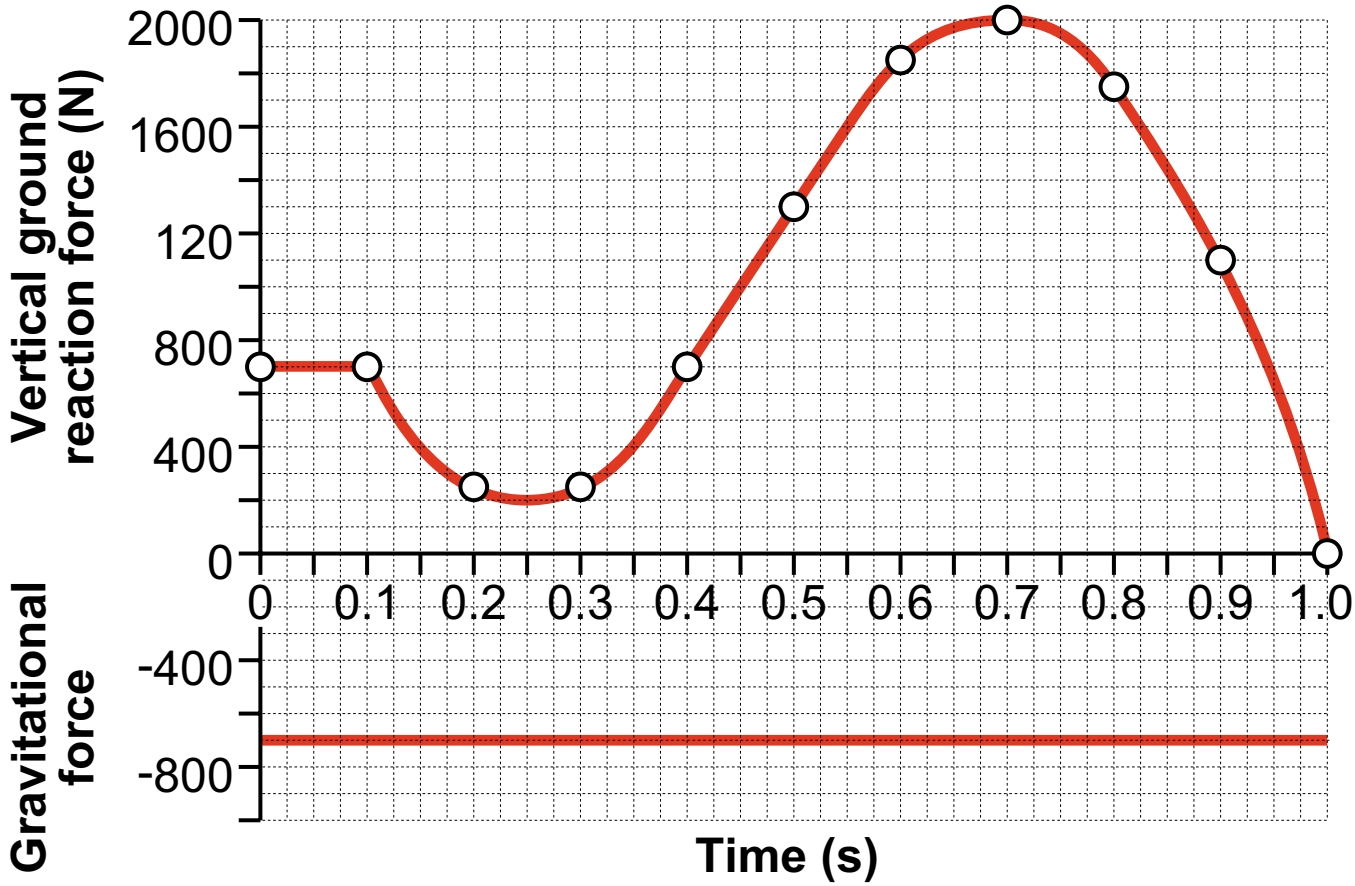
If ground reaction force > gravitational force
then net force is **positive**

If ground reaction force < gravitational force
then net force is **negative**

18 Linear Motion

The Vertical Jump

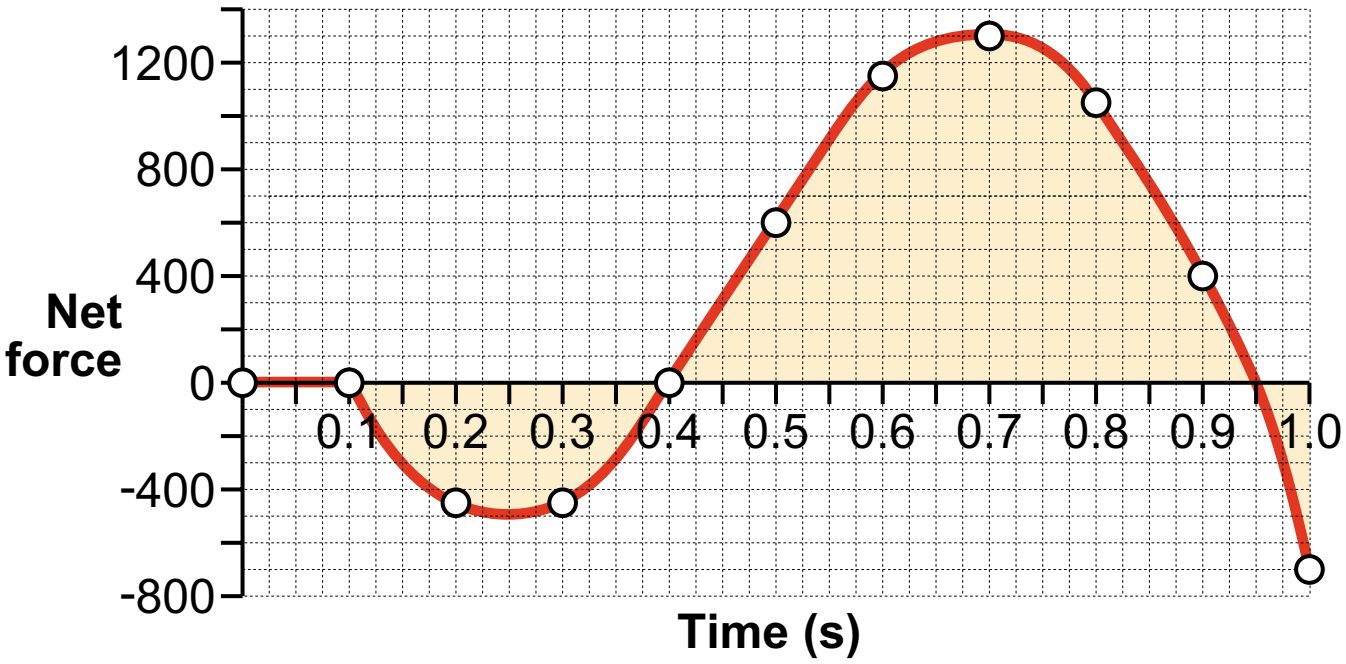
Graph showing the vertical ground reaction force and gravitational force acting on a jumper during the take-off phase of a vertical jump.



19 Linear Motion

The Vertical Jump

Graph showing a representation of the net impulse acting during the take-off phase of a vertical jump.



Shaded areas represent net impulse.

Images for BIOMECHANICS

Centre of Gravity (Centre of Mass)

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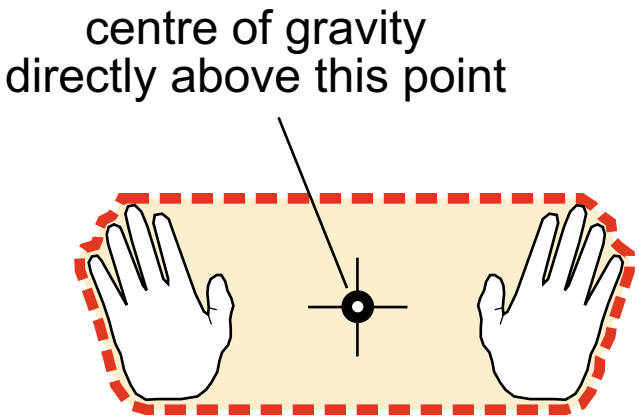
20 Centre of Gravity

Net Force & Centre of Gravity

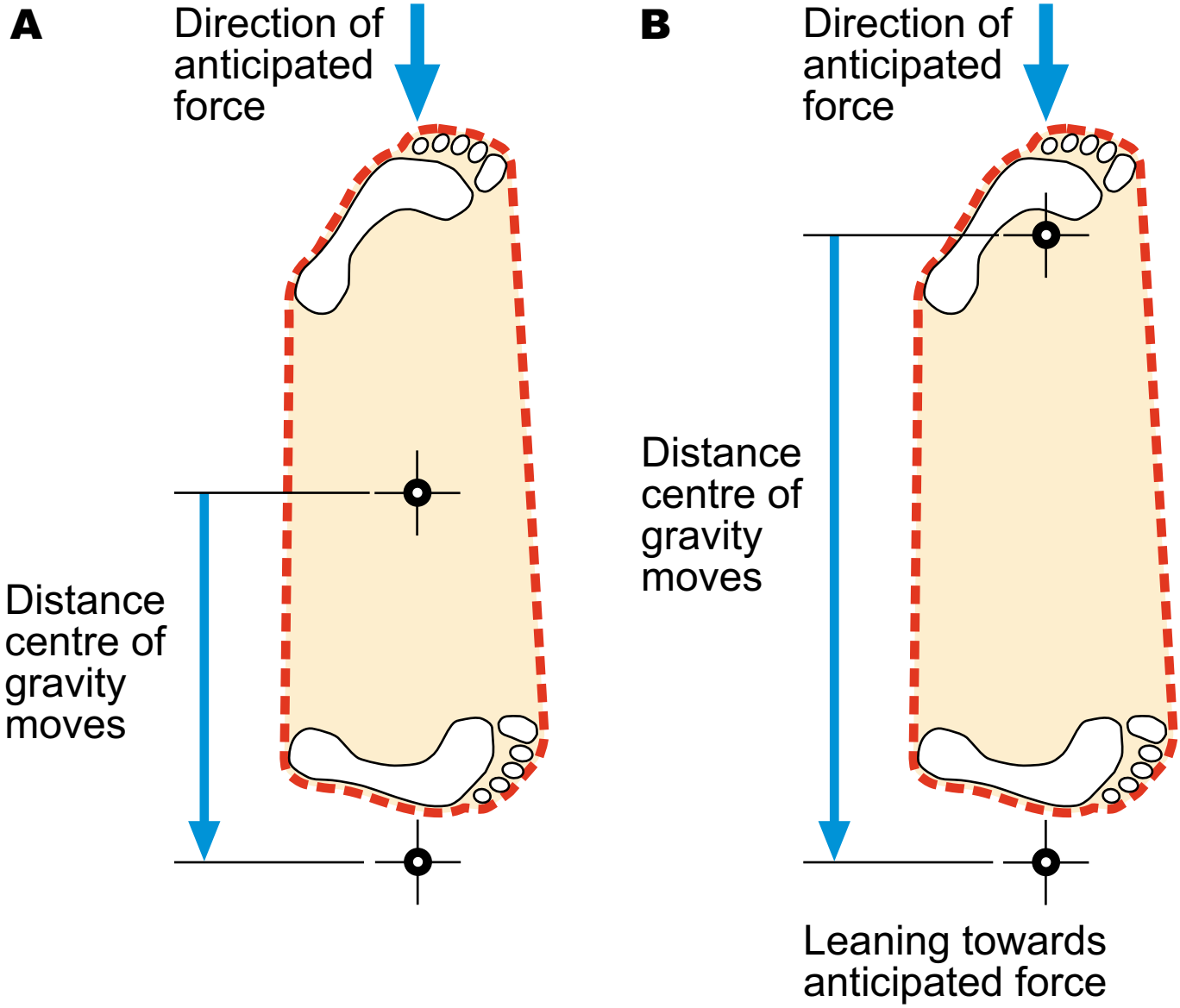
The handstand



21 Centre of Gravity

Net Force & Centre of Gravity

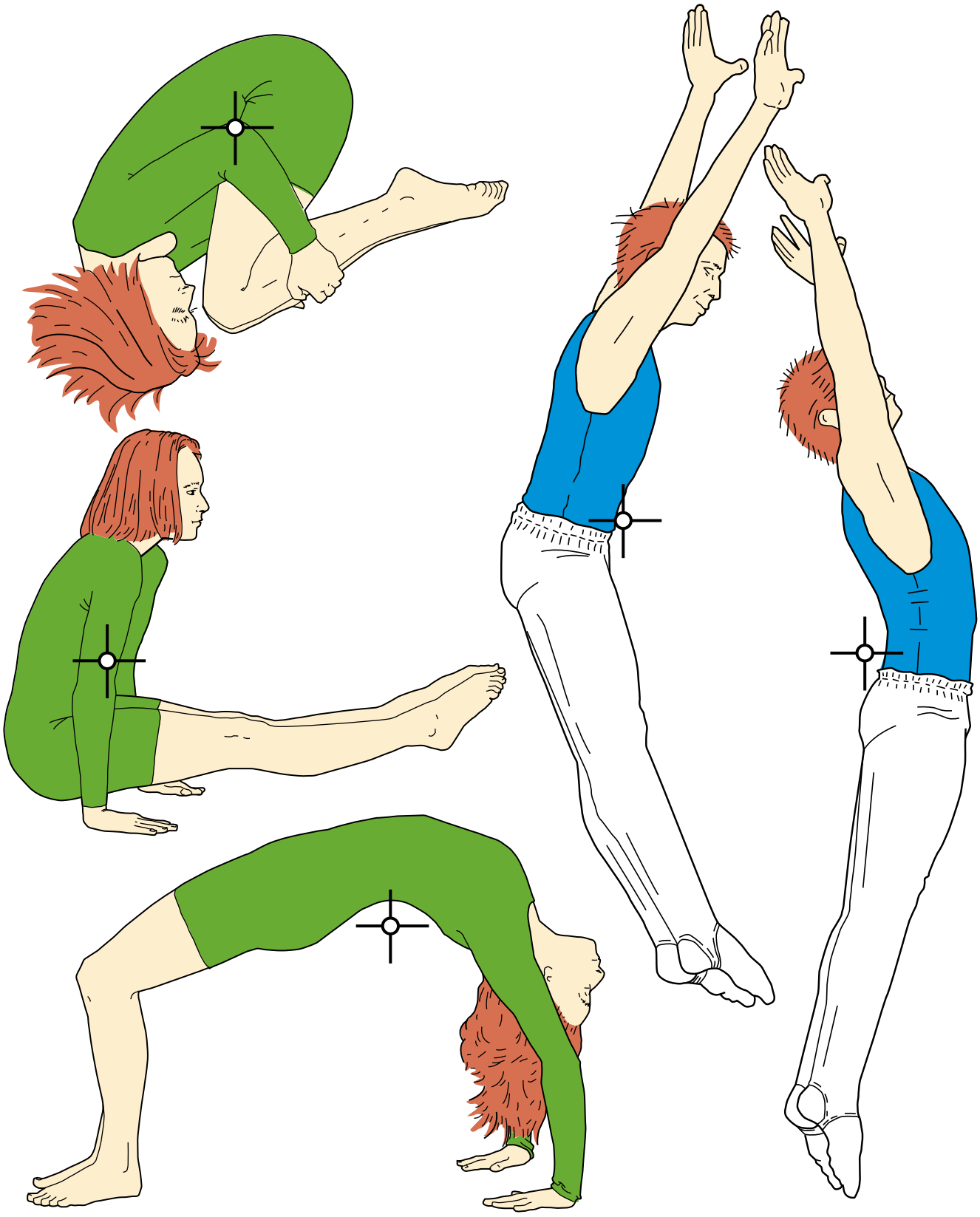
Withstanding impact from the side.



22 Centre of Gravity

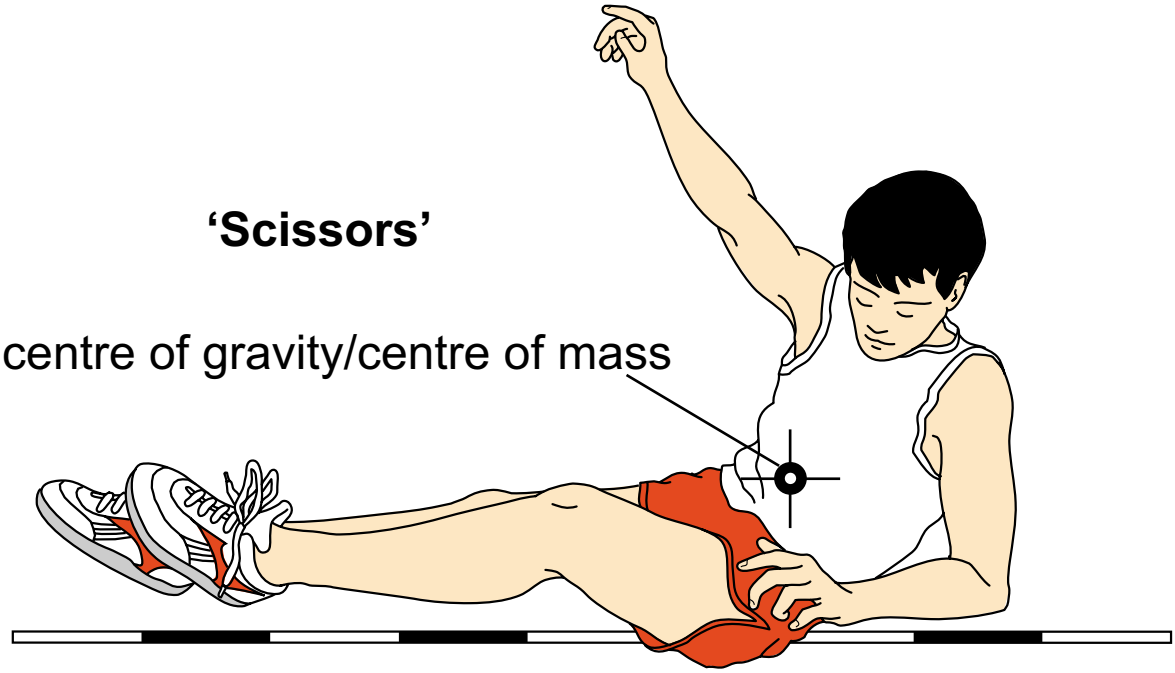
Changing Position of the Centre of Gravity

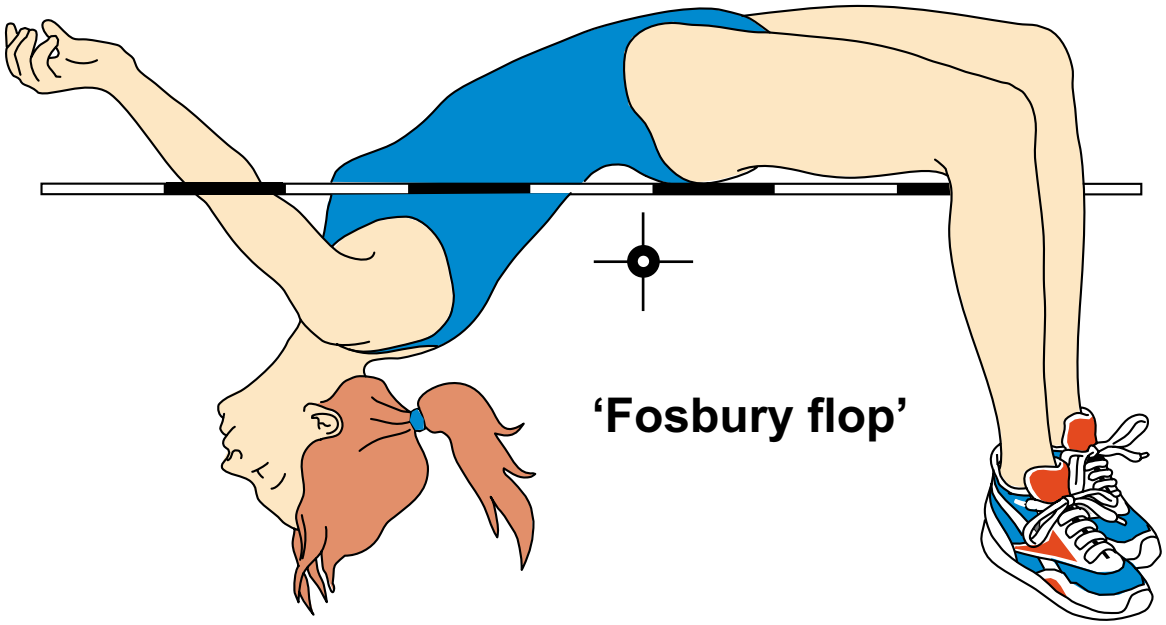
Various body positions.



23 Centre of Gravity High Jump Technique

The ‘scissors’ and ‘Fosbury flop’.



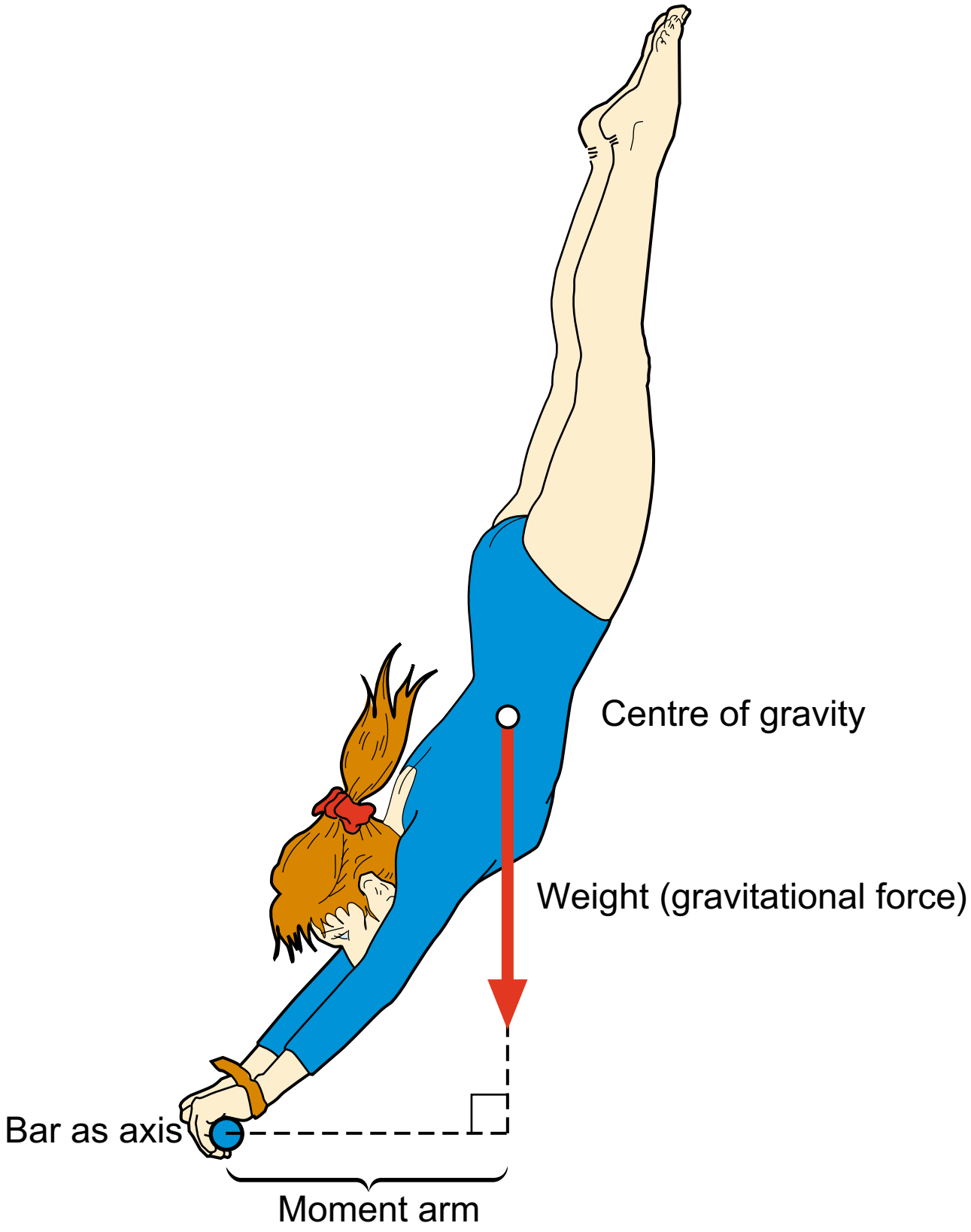


Images for BIOMECHANICS

Angular Motion

24 Angular Motion Rotation

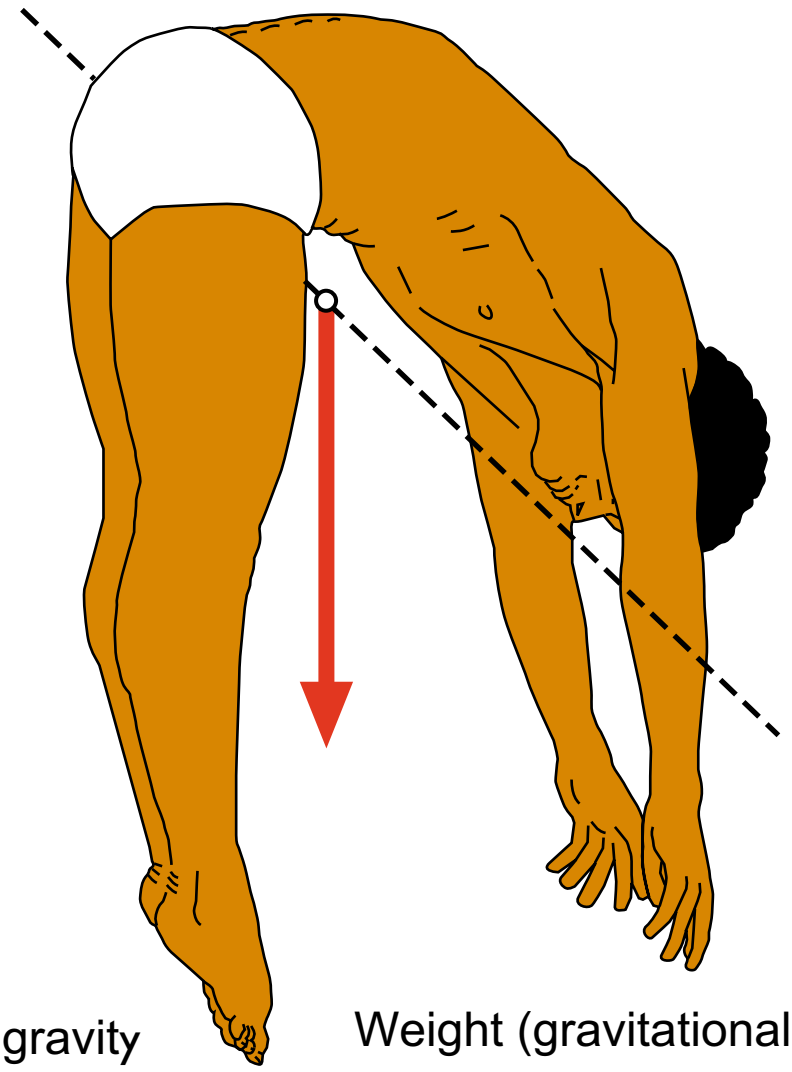
Weight generating torque force about a supported axis.



25 Angular Motion Rotation

Weight generating torque force about a non-supported Axis.

Axis passing through centre of gravity

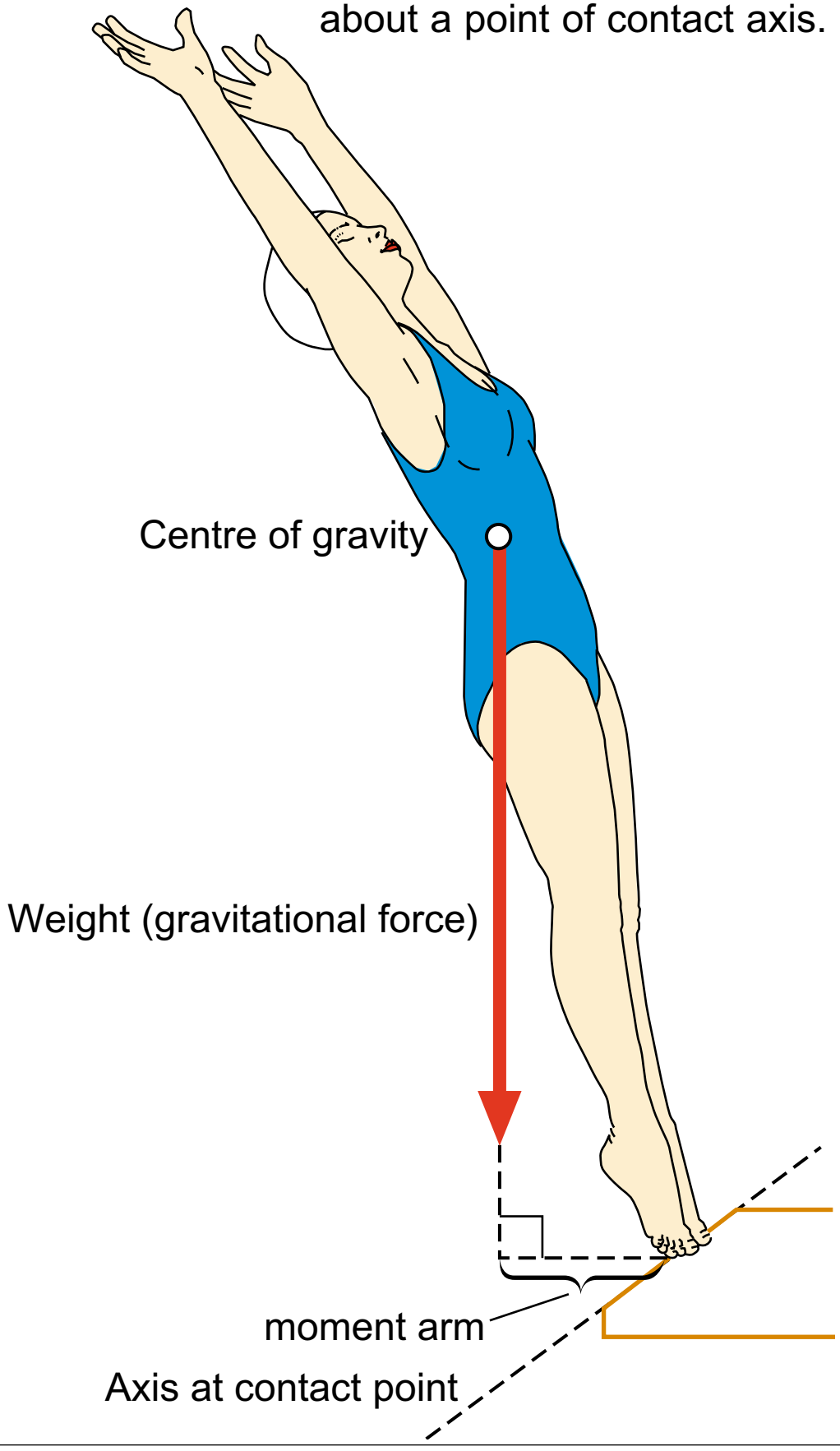


o = Centre of gravity

Weight (gravitational force)

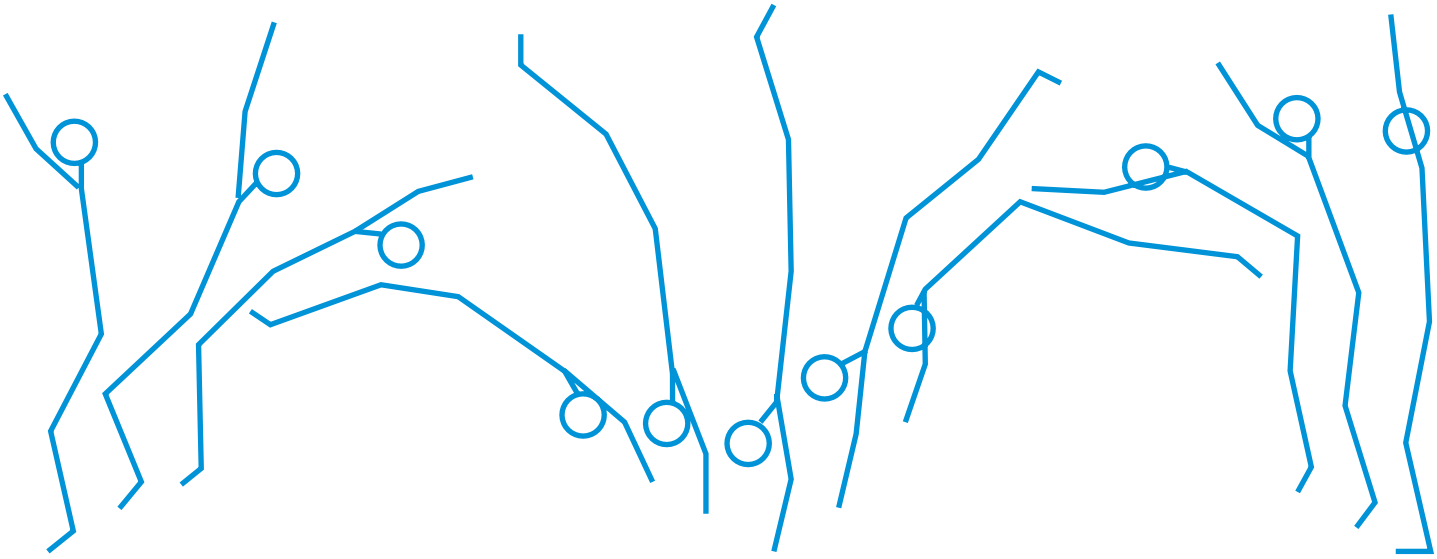
26 Angular Motion Rotation

Weight generating torque force about a point of contact axis.



27 Angular Motion Rotation

Stages of a flick-flak
(0.08 second intervals).

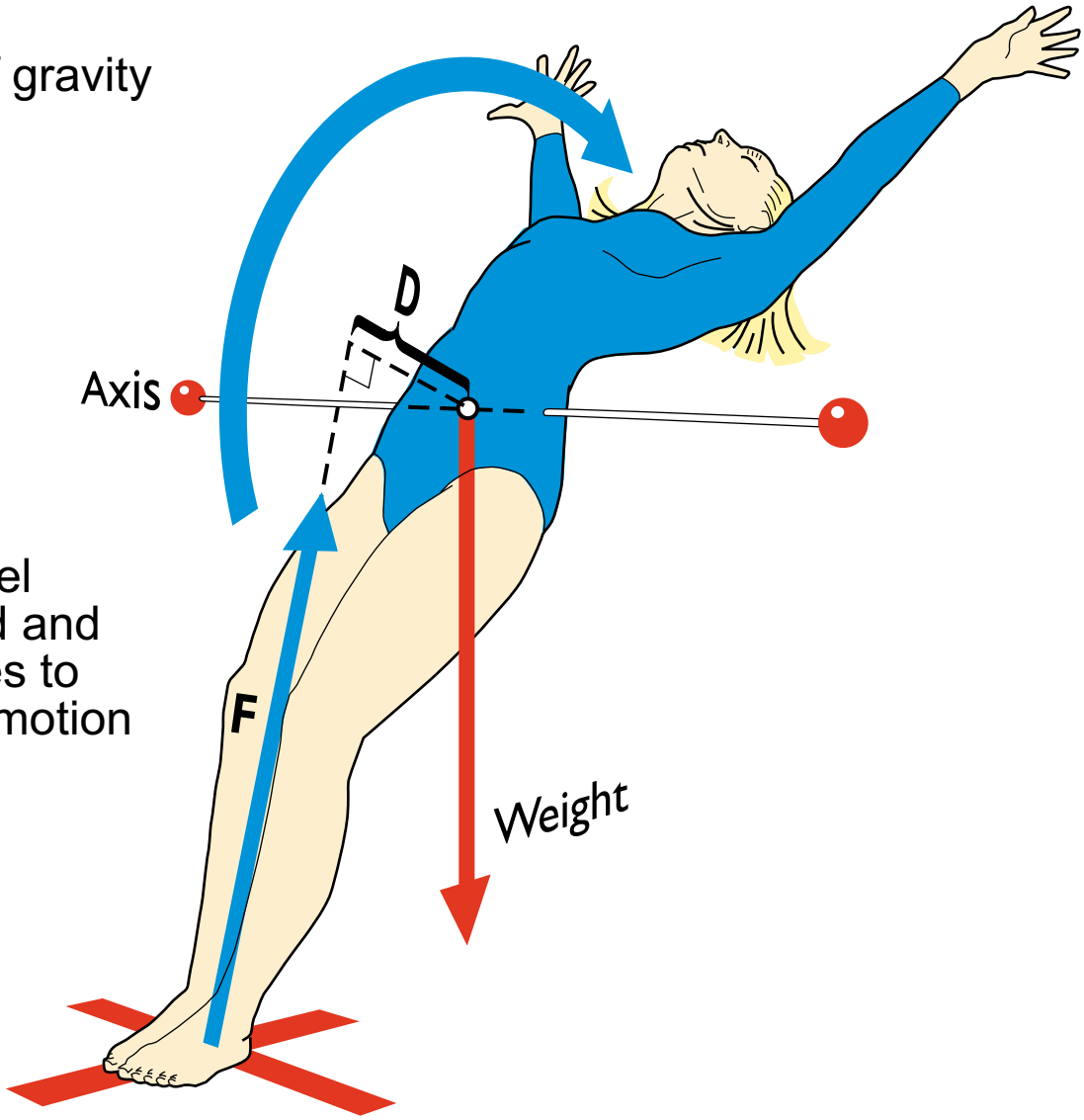


28 Angular Motion Rotation

Ground reaction force generating torque

F = Ground reaction force
D = Perpendicular distance between line of action of the ground reaction force and the centre of gravity (axis)

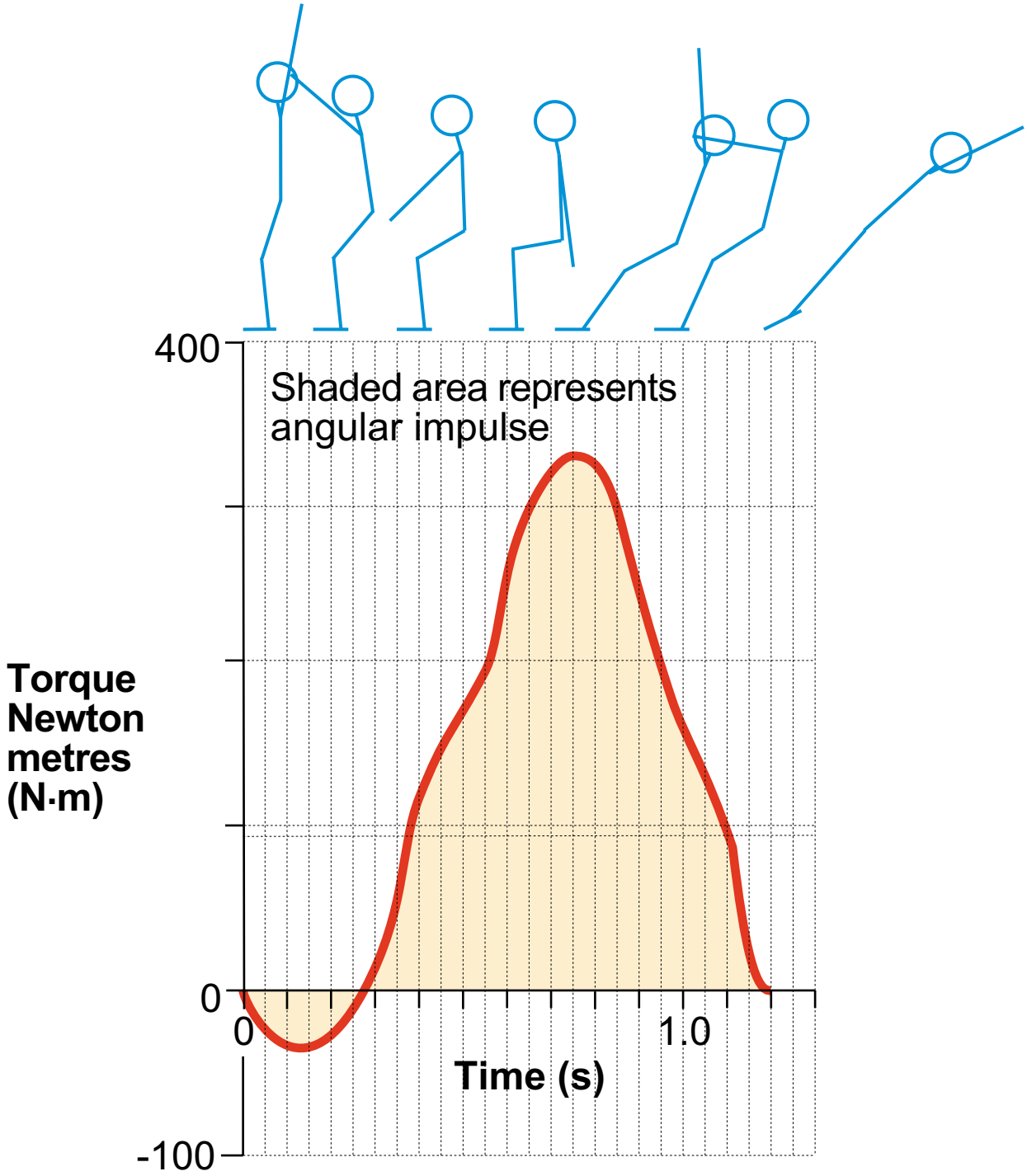
o = Centre of gravity



Axis is parallel to the ground and at right angles to the plane of motion

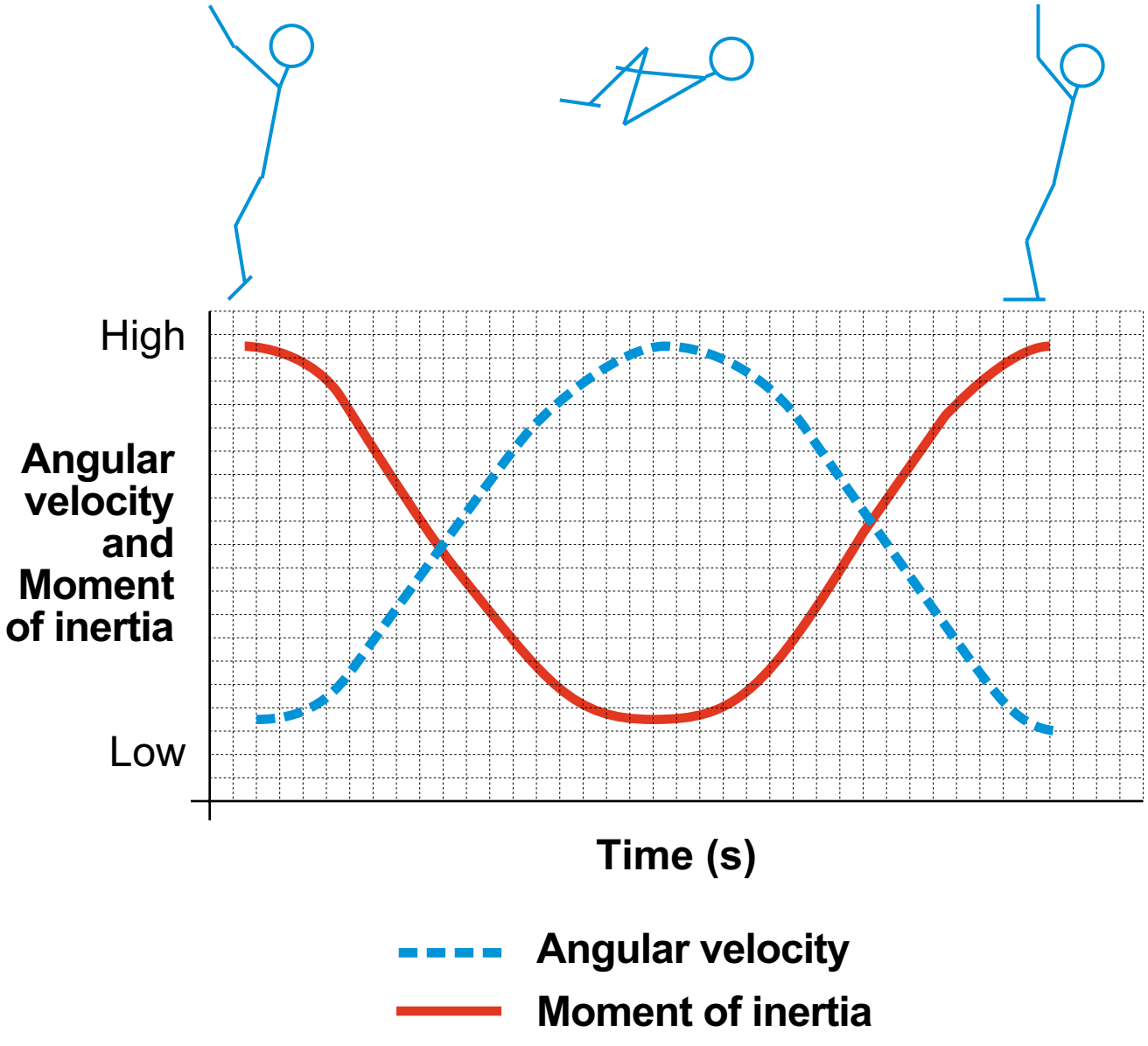
29 Angular Motion Rotation

Graph showing torque force and angular impulse during the take-off phase of a flick-flack.



30 Angular Motion Rotation

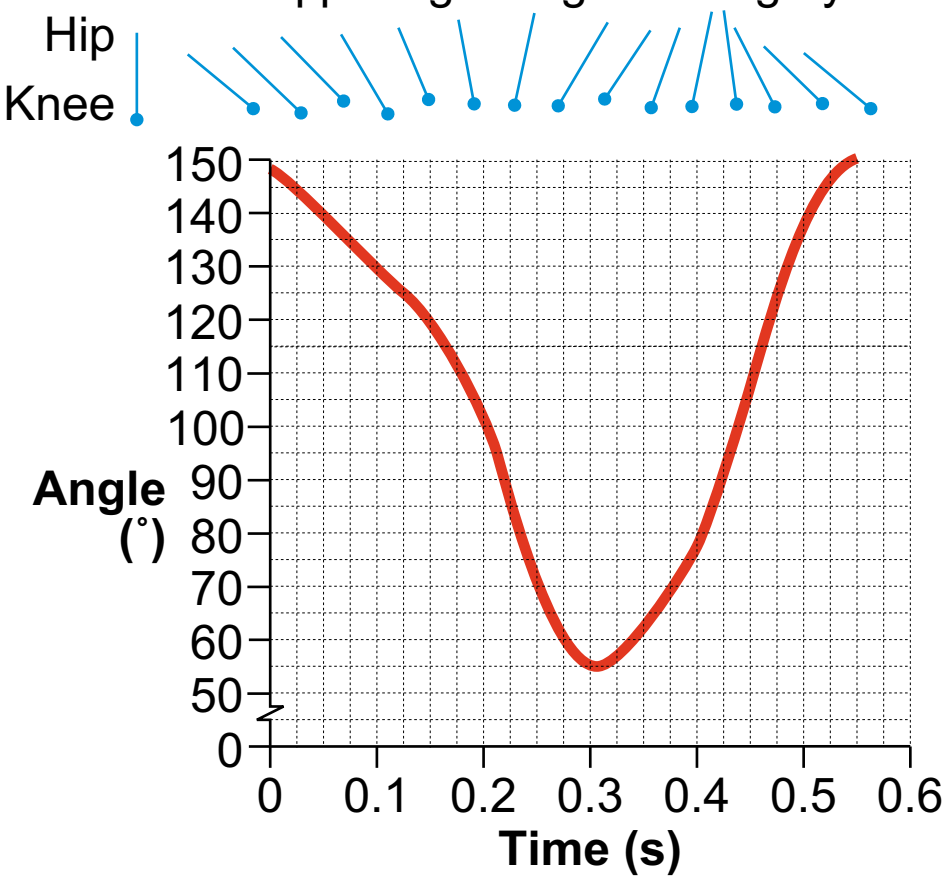
Graph showing the the relationship between moment of inertia and angular velocity in a standing back somersault (flight phase).



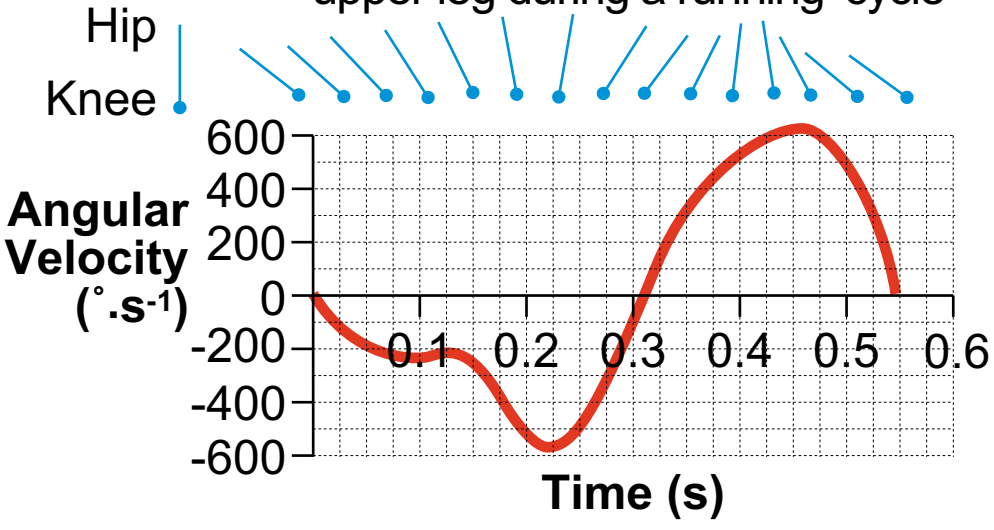
31 Angular Motion Angular Velocity

Graphs showing angular position and angular velocity of upper leg during a running cycle.

Graph of angular position of upper leg during a running 'cycle'



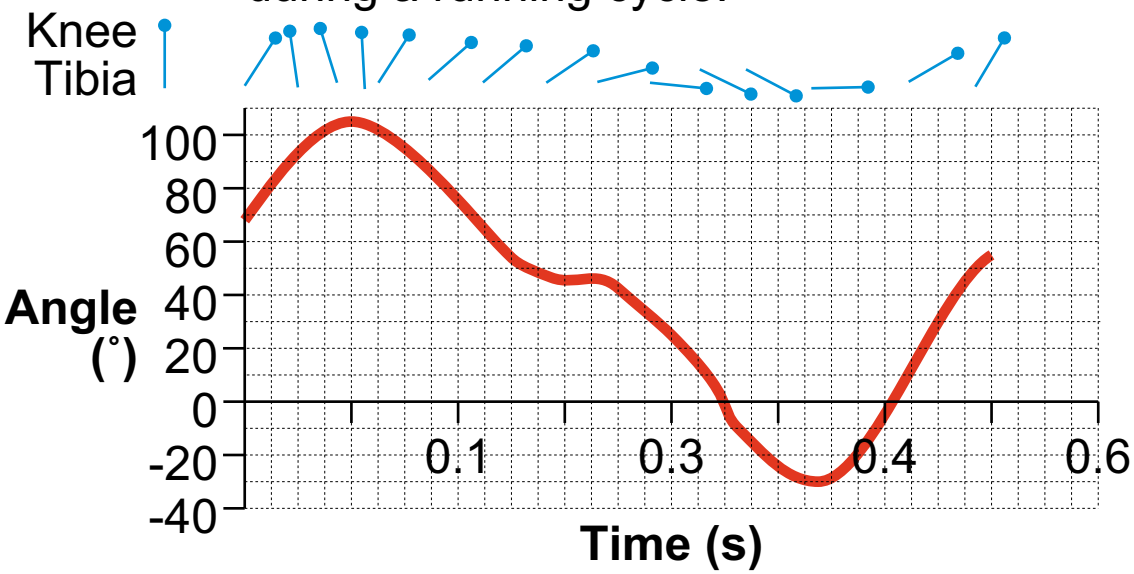
Graph of angular velocity of upper leg during a running 'cycle'



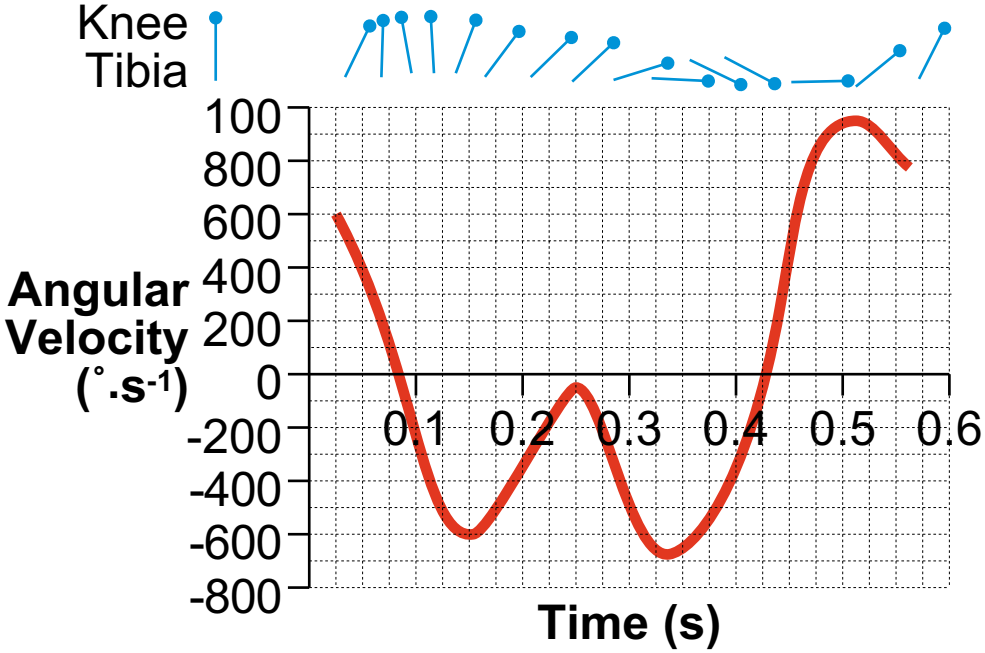
Angular Velocity

Graphs showing angular position and angular velocity of lower leg during a running cycle.

Graph of angular position of lower leg during a running cycle.



Graph of angular velocity of lower leg during a running cycle



Images for BIOMECHANICS

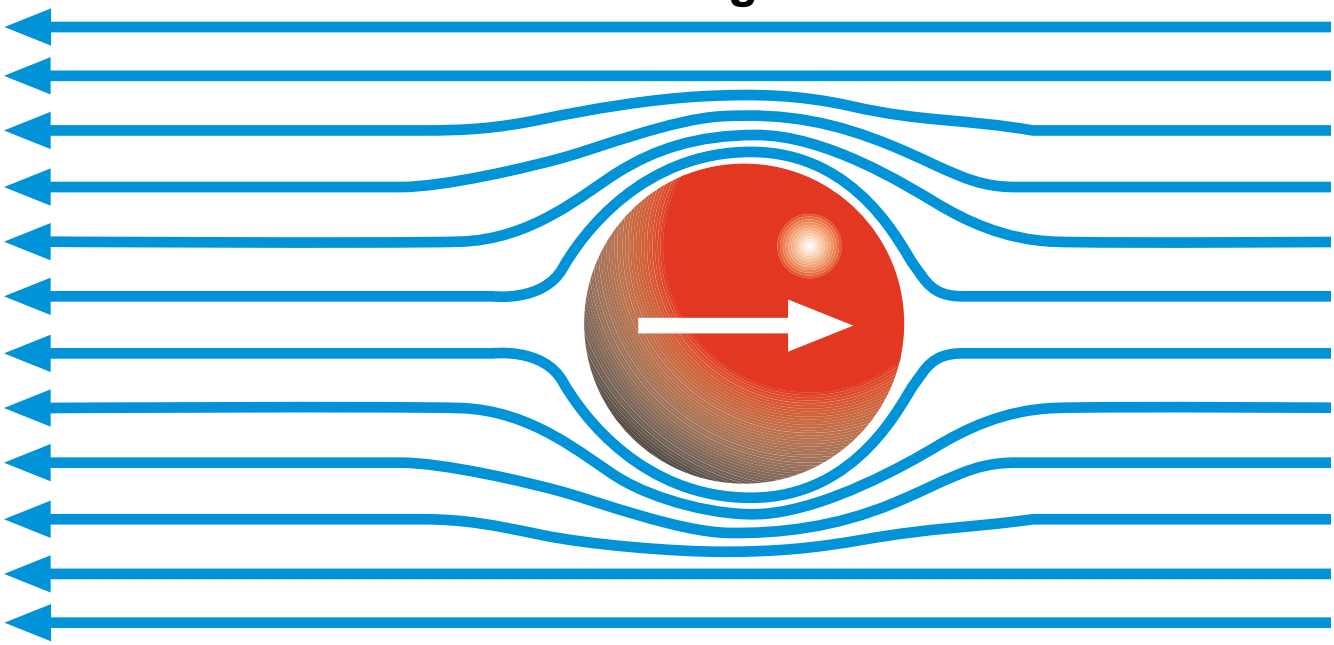
Fluid Forces

33 Fluid Forces

Bernoulli Effect

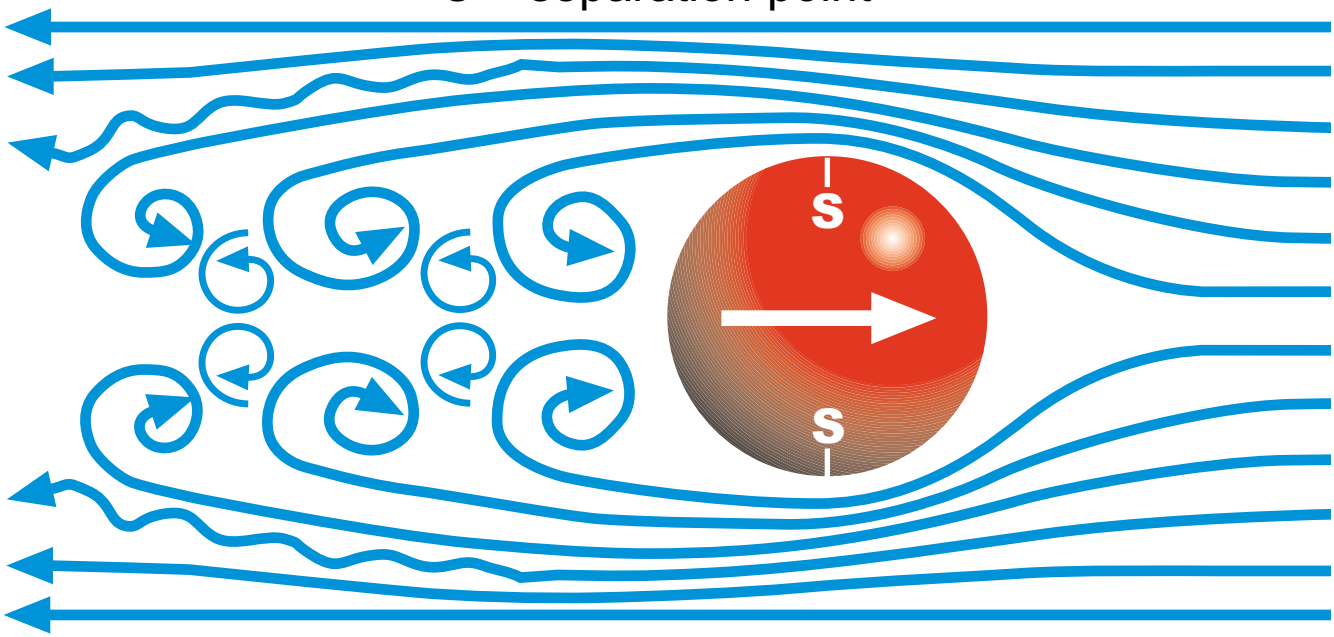
Laminar flow around a slow moving ball and a fast moving ball

Slow moving ball



Fast moving ball

s = separation point

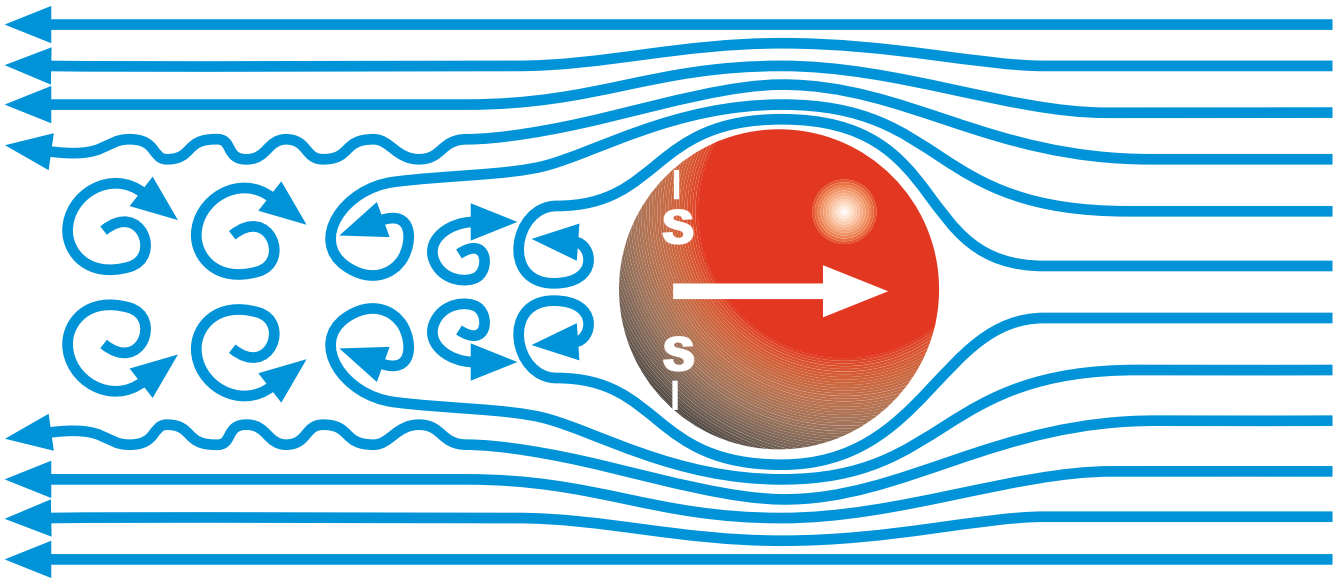


34 Fluid Forces

Reduced Drag

Late separation of air flow by travelling above the critical velocity.

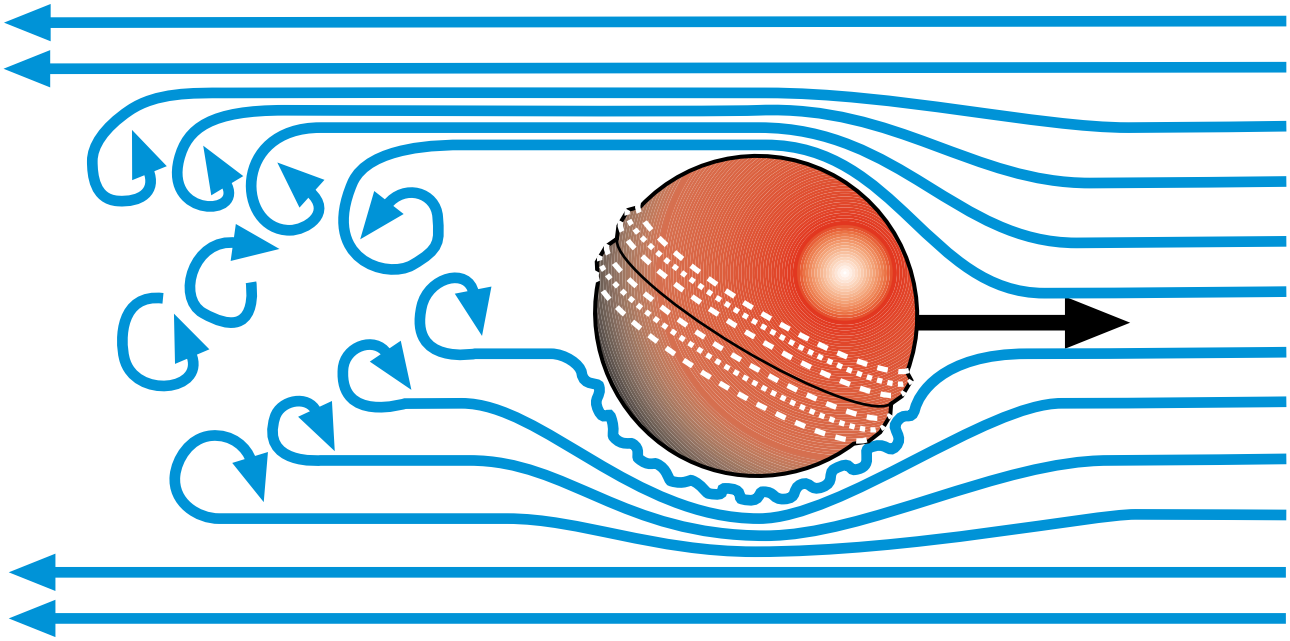
S = separation point



35 Fluid Forces

Swing

Disturbing the air using the seam on a cricket ball

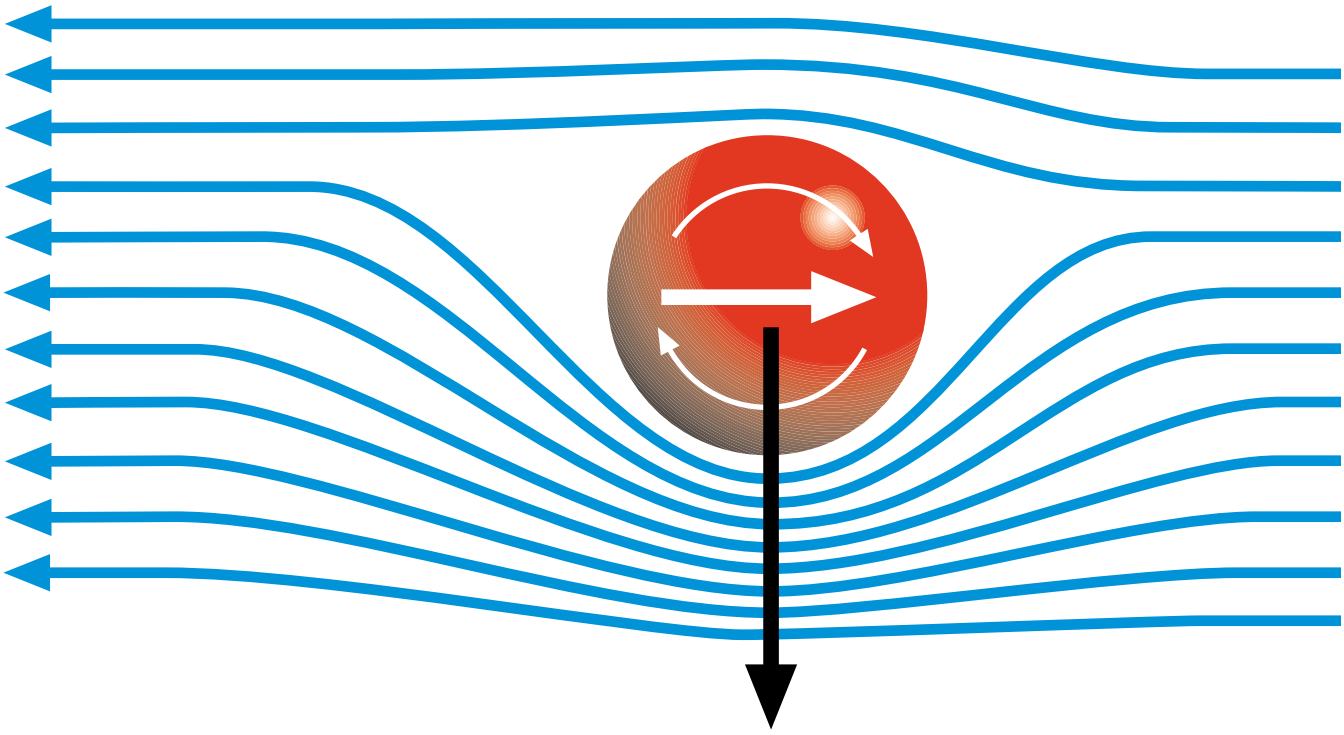


As seen from above.

36 Fluid Forces

Magnus Effect

Lift force created by ‘spin’, here showing ‘top-spin’ forcing the ball downward.

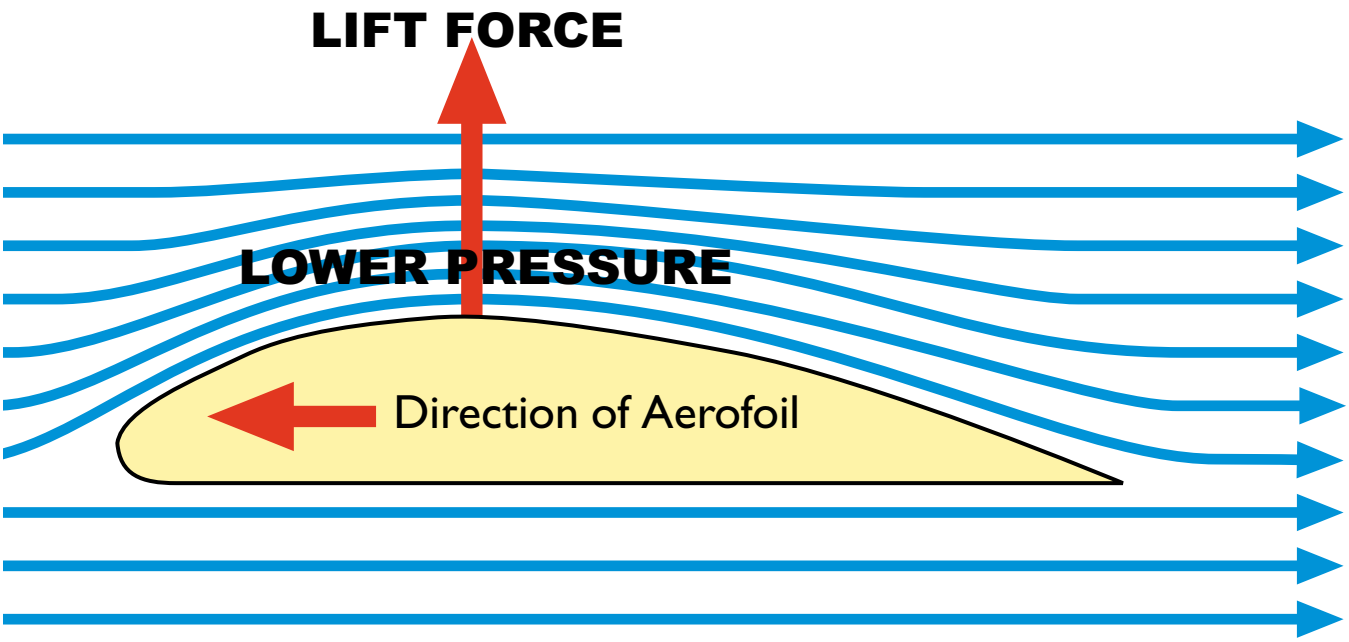


Magnus (lift) force acting downward

37 Fluid Forces

Magnus Effect

Lift force is at 90º to the direction of travel.

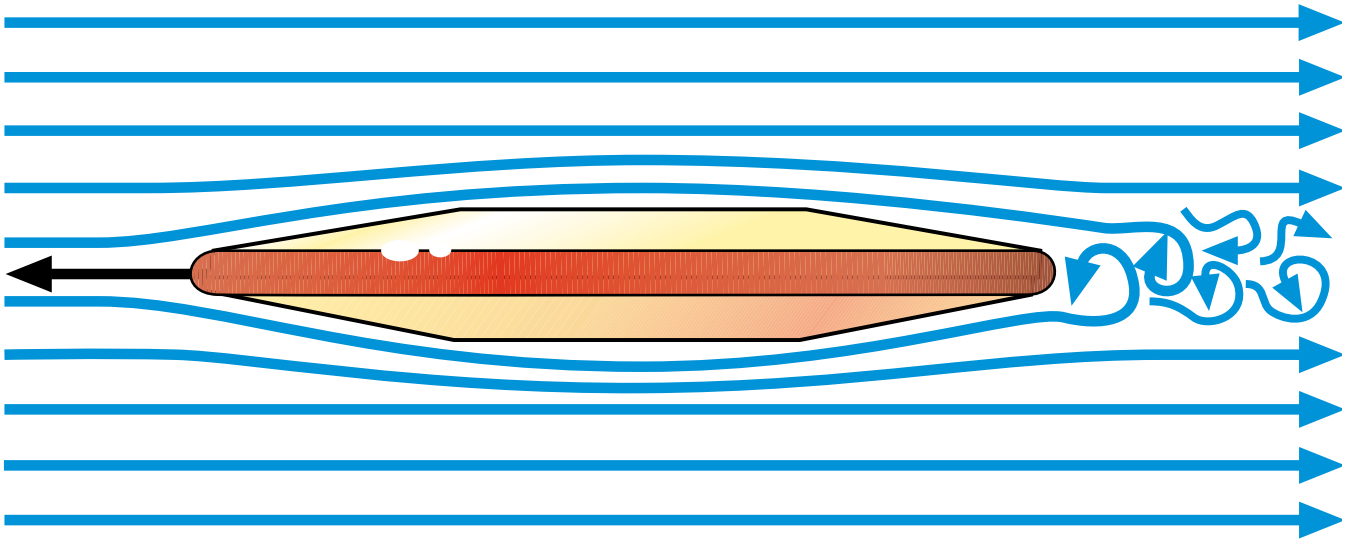


The air on the upper side of the aerofoil is displaced up, increasing its velocity and decreasing the pressure.

38 Fluid Forces

Boundary Layer

Laminar flow around a discus



Images for BIOMECHANICS

Parabolas

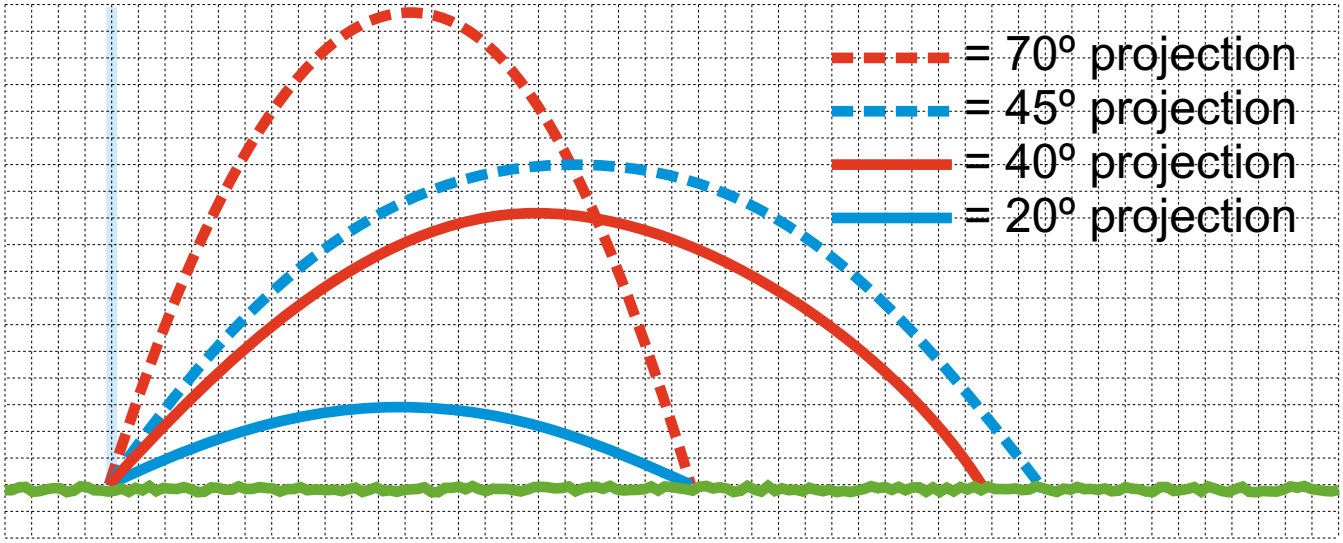
39 Parabolas Symmetry

The symmetrical parabola.

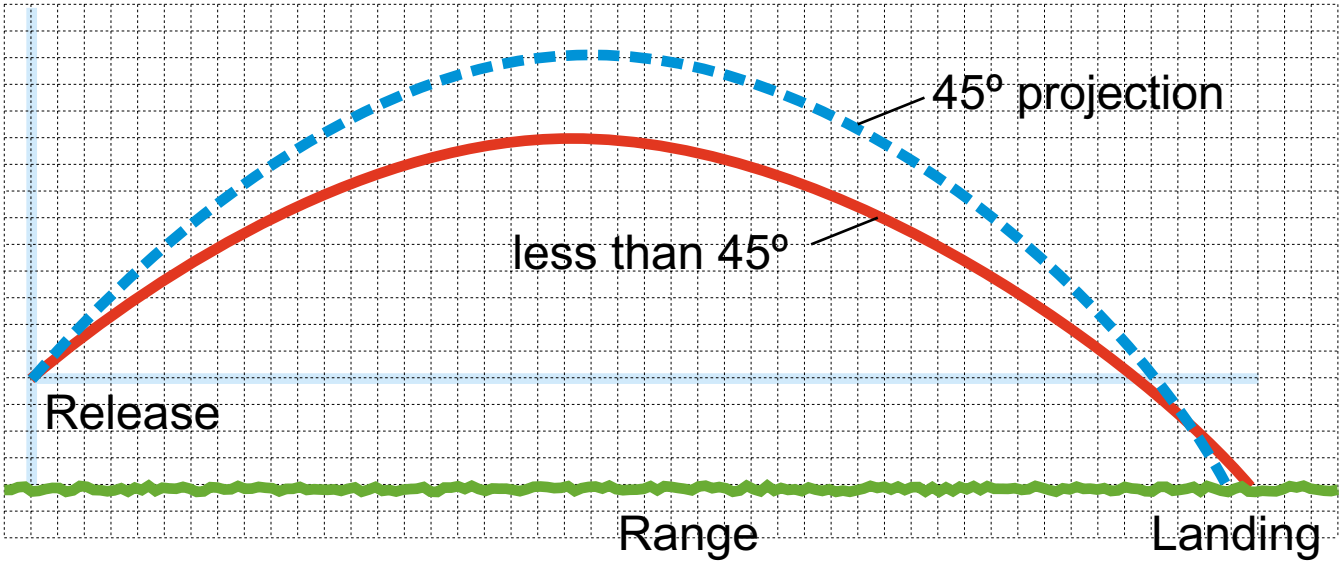
40 Parabolas Range

Optimum release angle for height for maximum range.

Note that the parabolas are symmetrical and maximum distance for a given force and height of release requires optimum angle of launch.

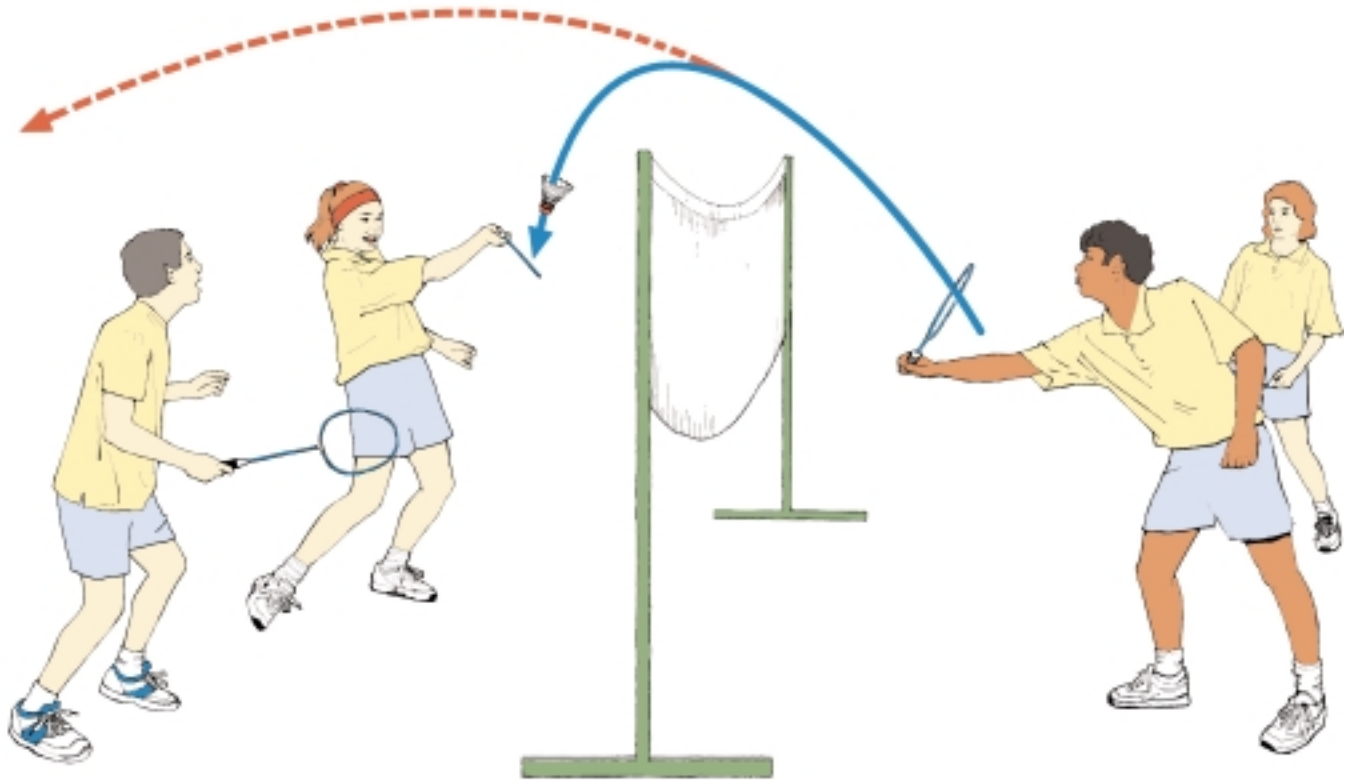


Height of release alters optimum angle of launch.



41 Parabolas Air Resistance

Asymmetrical parabolic flight path due to air resistance

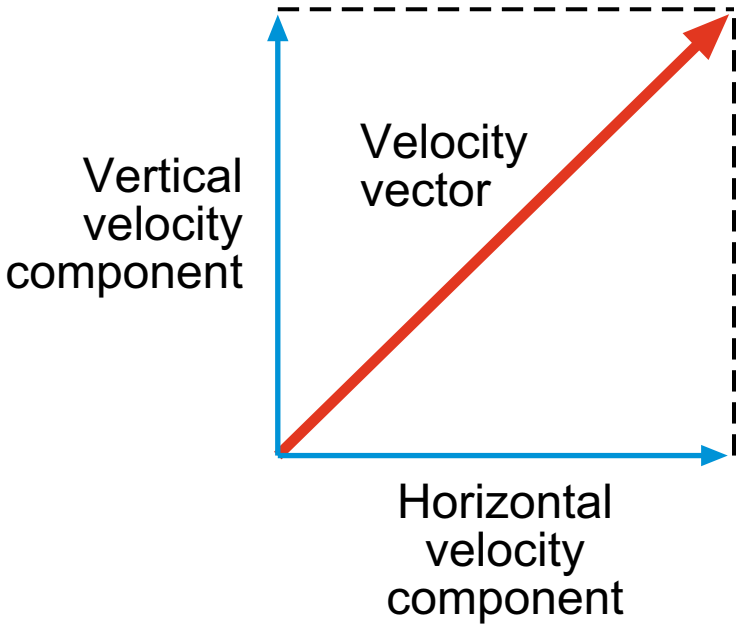


The diagram shows asymmetrical flight path of a shuttlecock, due to air resistance. If the shuttlecock did not have feathers, which increase air resistance, it would have followed the symmetrical flight path indicated by the dotted line, since air resistance would then be negligible.

42 Parabolas

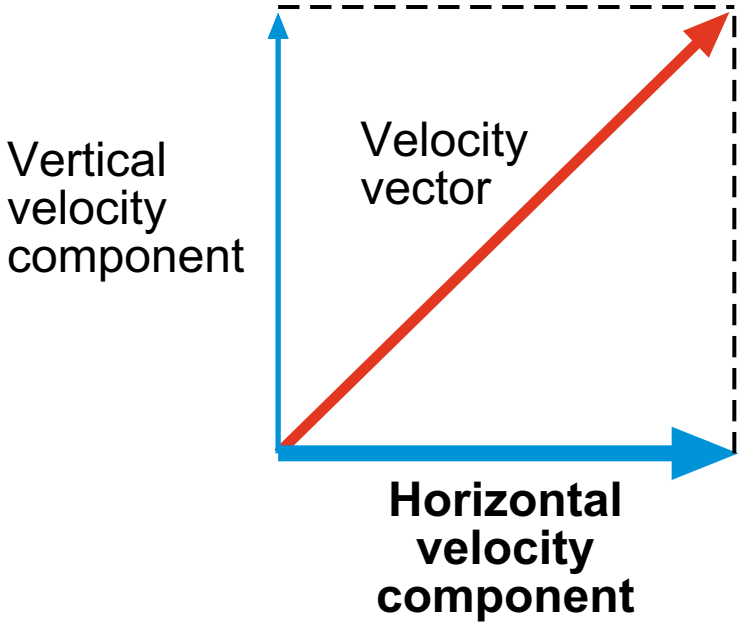
Velocity Vector

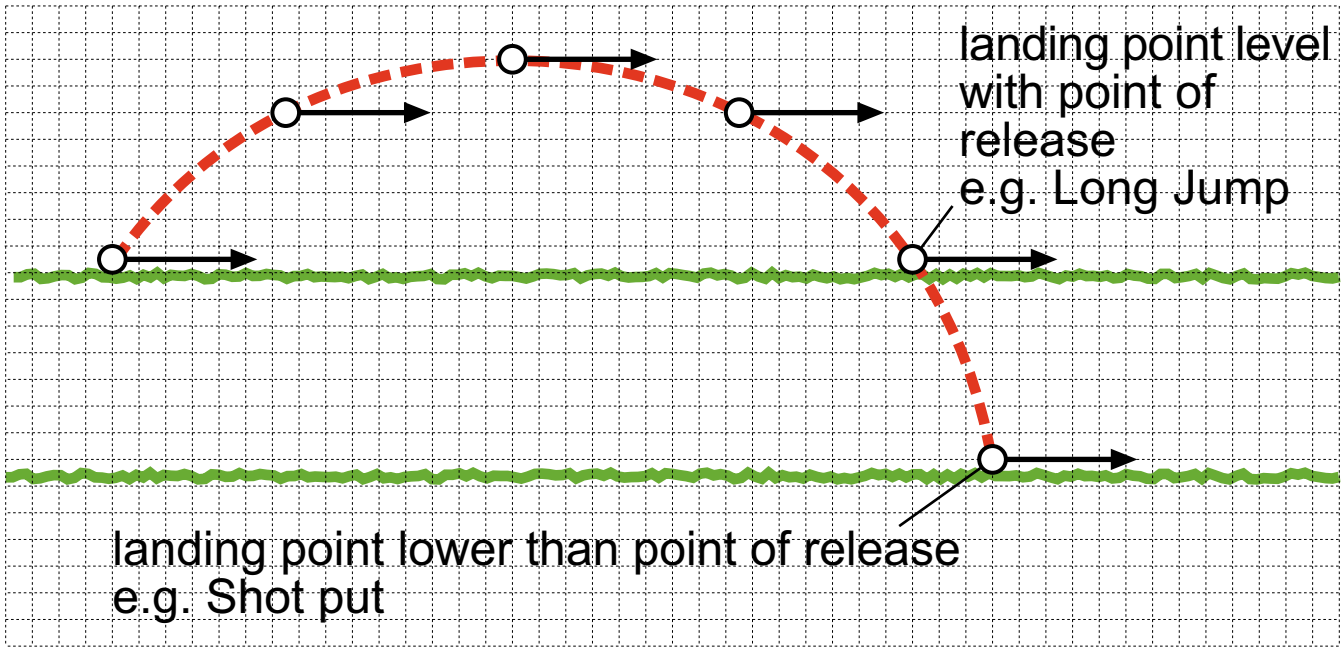
Resultant of vertical velocity component and horizontal velocity component.



43 Parabolas Velocity Vector

Parabolic flight path showing horizontal component only.

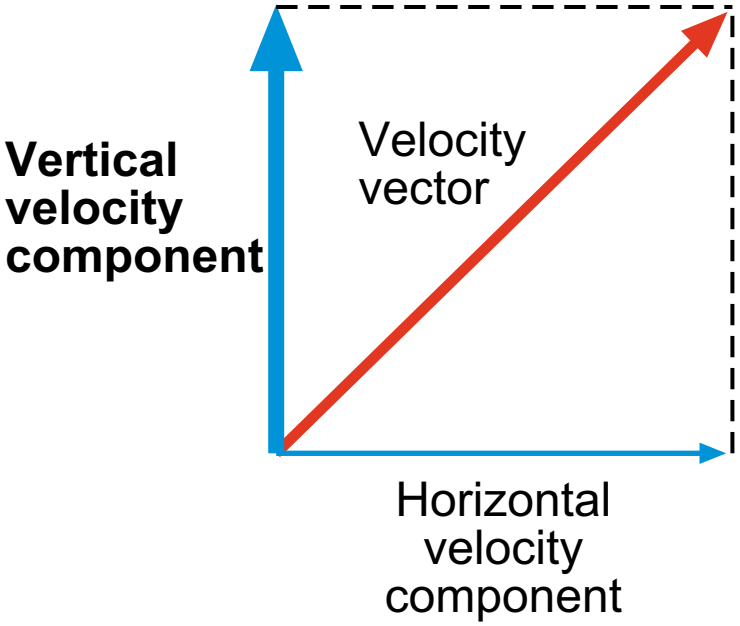


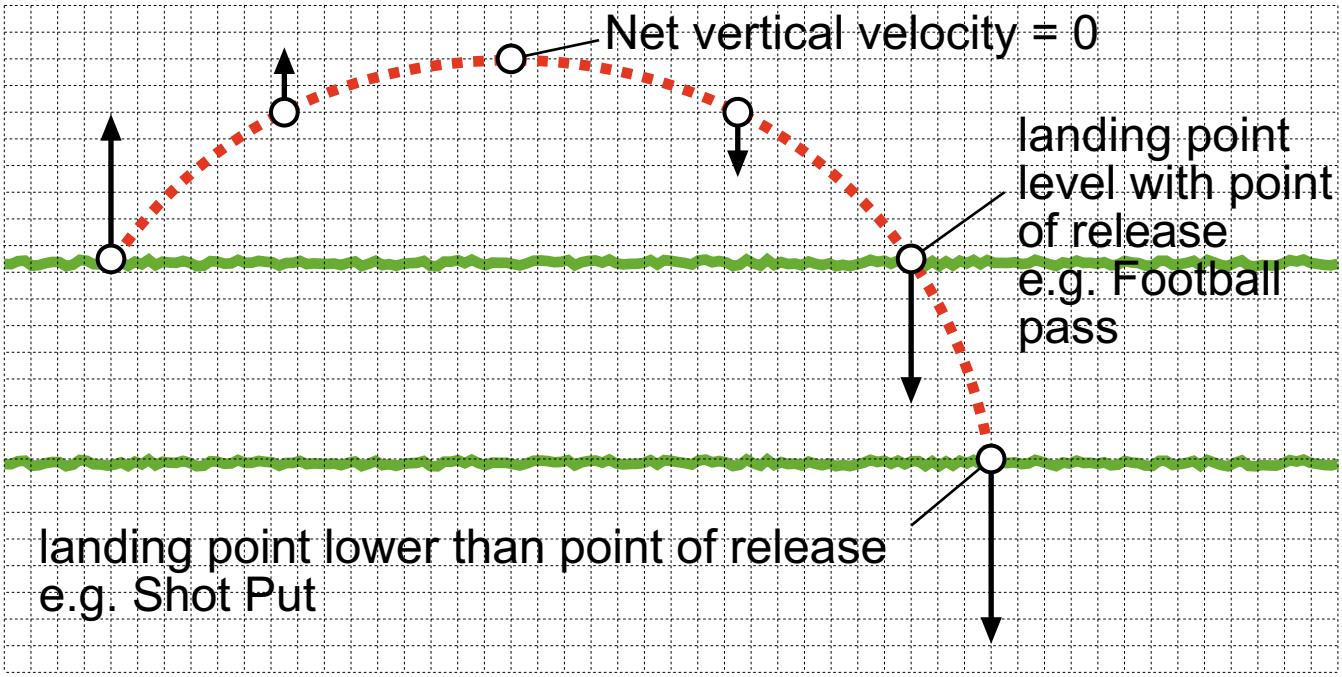


Note: Horizontal velocity component is constant, as air resistance is considered negligible in these examples.

44 Parabolas Velocity Vector

Parabolic flight path showing vertical component only.

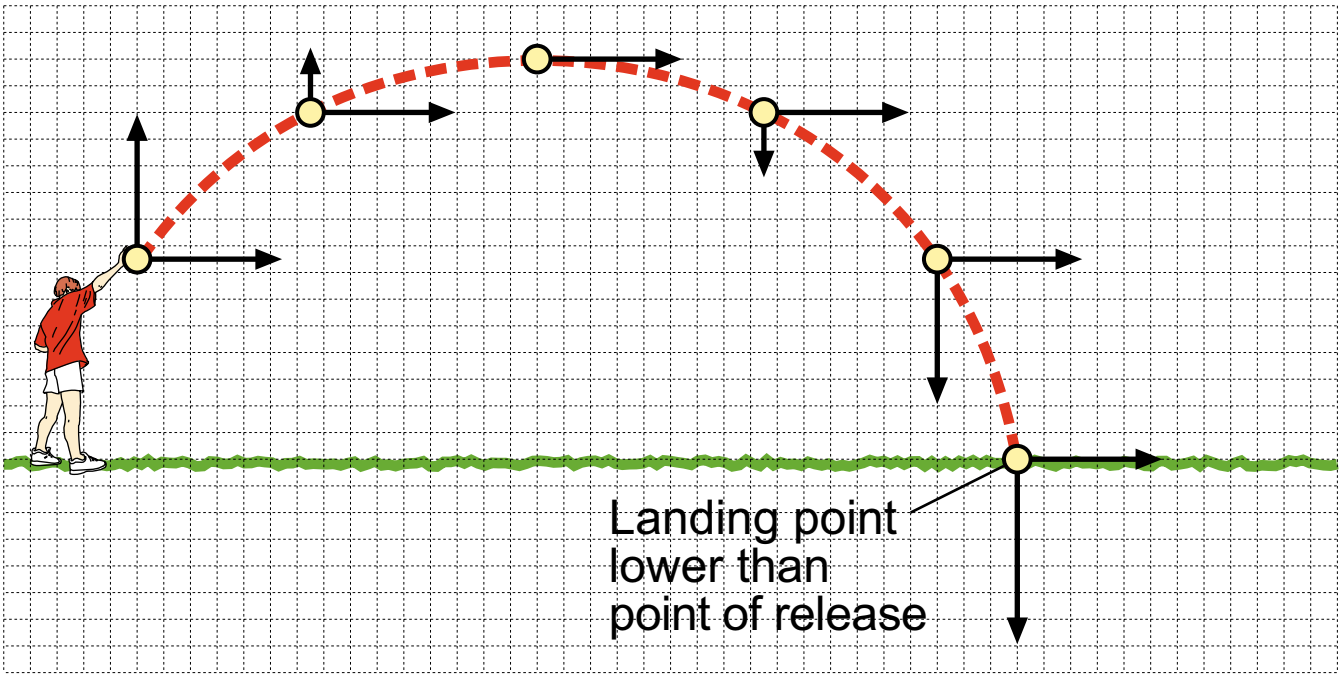



Net vertical velocity = 0
landing point level with point of release
e.g. Football pass
landing point lower than point of release
e.g. Shot Put

Note: Net vertical velocity component changes.

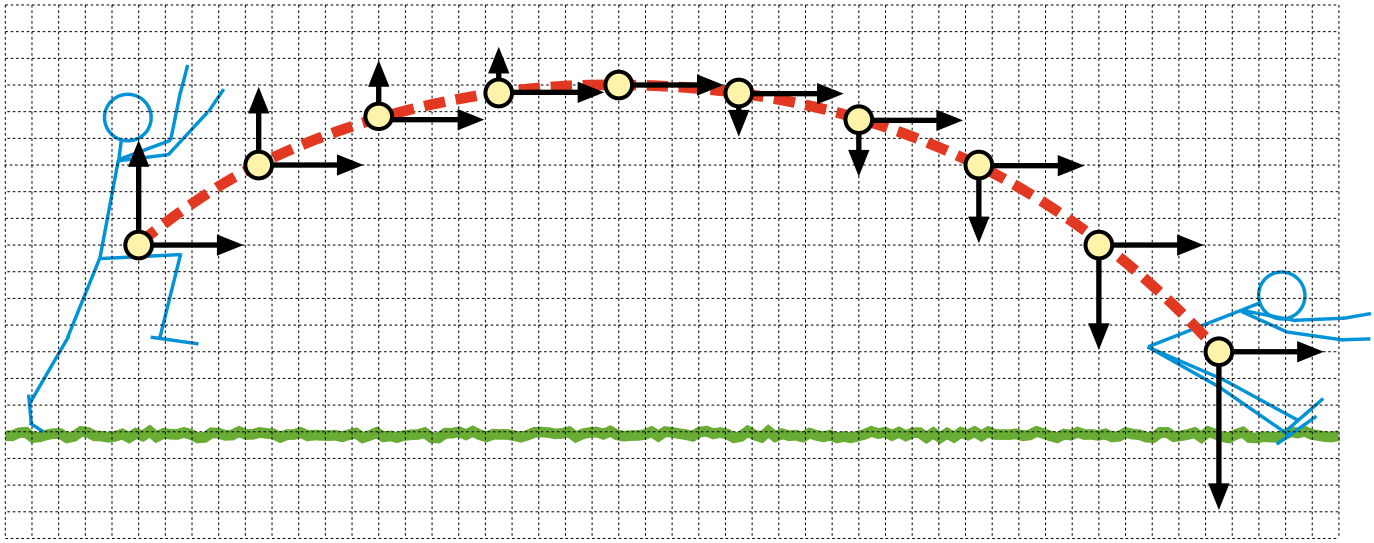
45 Parabolas Velocity Vector

Changes in the vertical velocity component of the parabolic flight path of a projectile (shot put) with the landing point lower than the release point.



46 Parabolas Velocity Vector

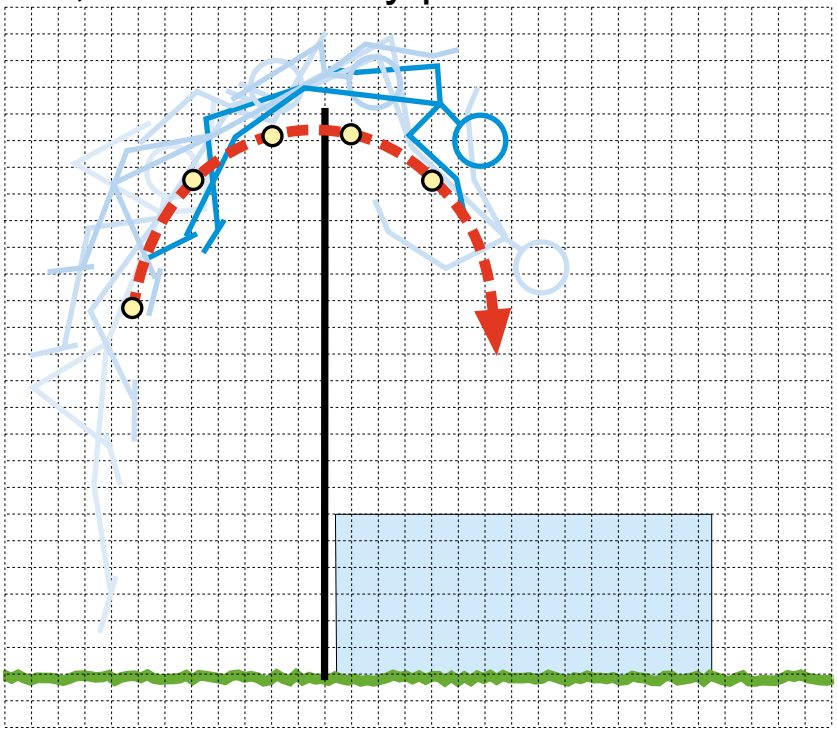
Vertical and horizontal velocity components of a long jump flight parabola.



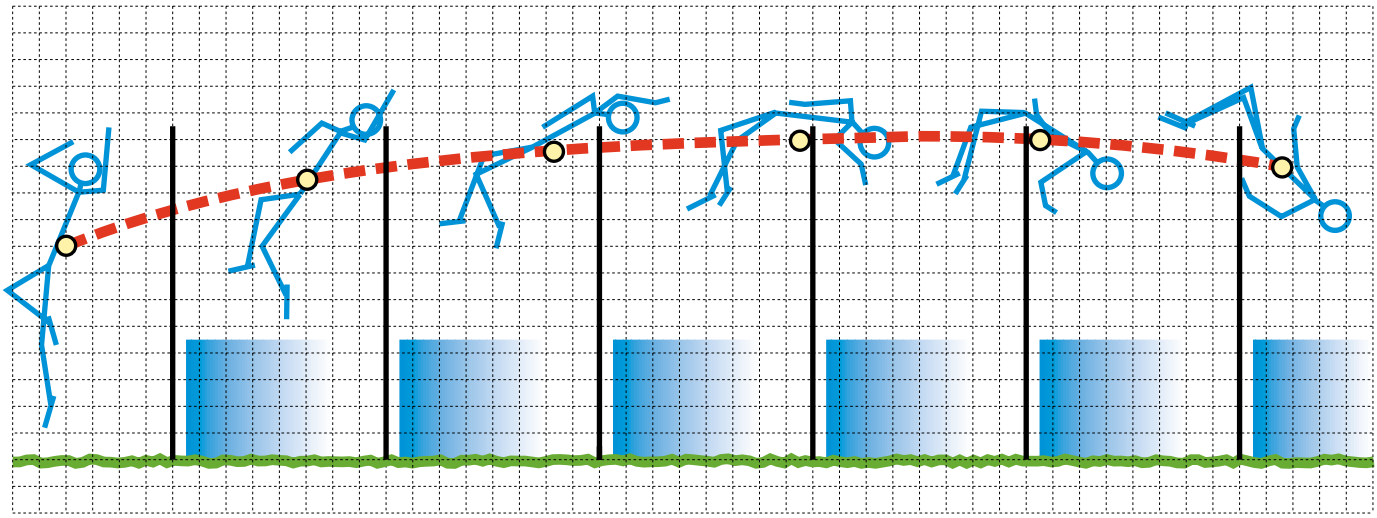
47 Parabolas Jumps

Centre of gravity parabola of ‘Fosbury flop’.

The symmetrical parabola described by the centre of gravity passes beneath the bar, while the body passes above.

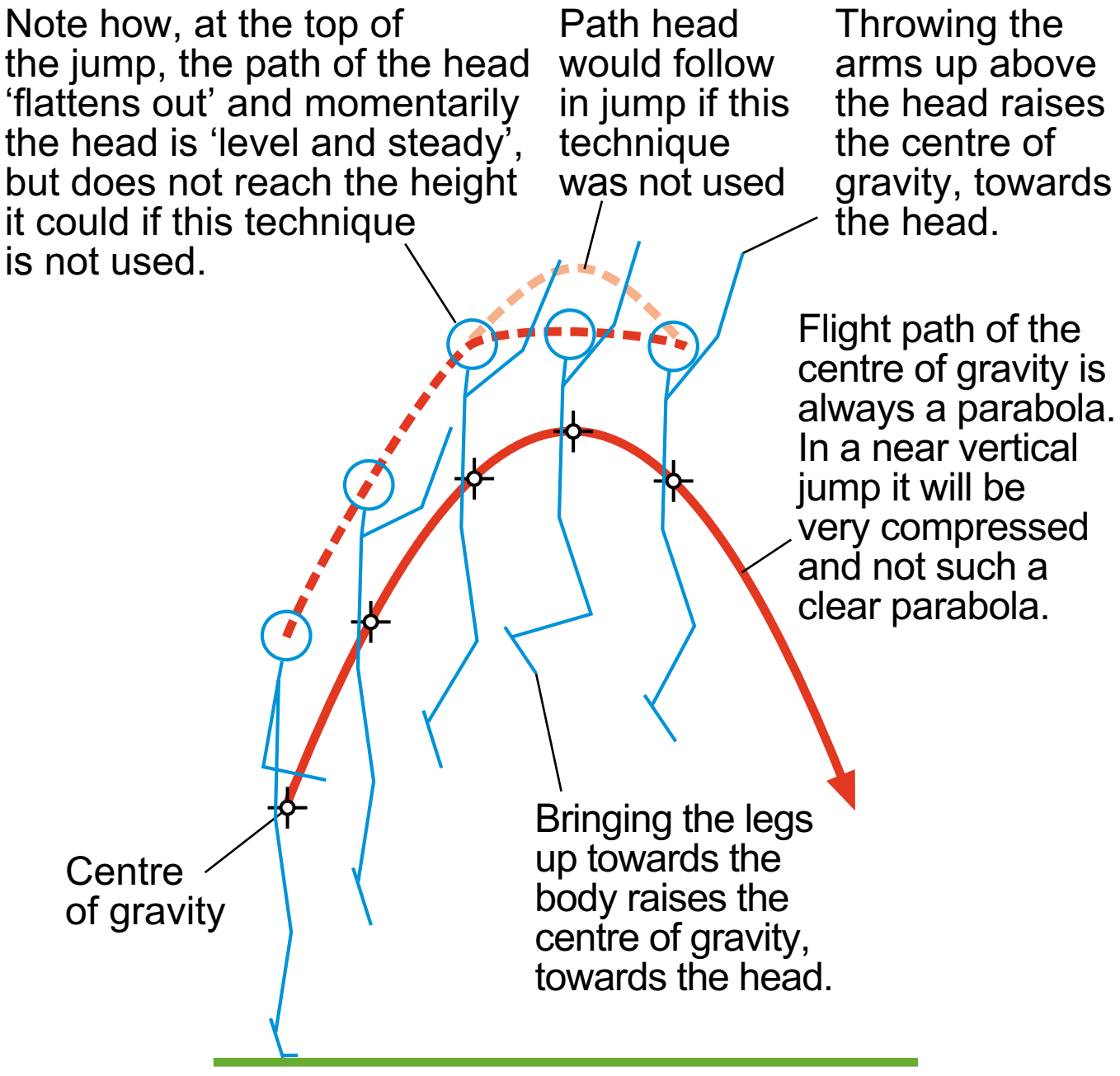


Below is the same parabola arbitrarily ‘stretched’ and diagrams of the figure spaced apart to help show the parabola described by the centre of gravity outside and below the body.



48 Parabolas Jumps

Altering the position of the body in relation to the centre of gravity in a jump to 'hang in the air'.


Note how, at the top of the jump, the path of the head 'flattens out' and momentarily the head is 'level and steady', but does not reach the height it could if this technique is not used.
Path head would follow in jump if this technique was not used
Throwing the arms up above the head raises the centre of gravity, towards the head.
Flight path of the centre of gravity is always a parabola. In a near vertical jump it will be very compressed and not such a clear parabola.
Centre of gravity
Bringing the legs up towards the body raises the centre of gravity, towards the head.